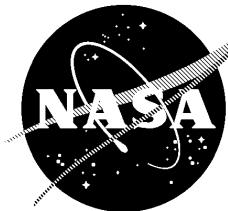


## NETWORK AND MISSION SERVICES PROGRAMS

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# INTERFACE CONTROL DOCUMENT BETWEEN THE DEMAND ACCESS SYSTEM (DAS) AND DAS CUSTOMERS

15 August 2001



National Aeronautics and  
Space Administration

Goddard Space Flight Center  
Greenbelt, Maryland

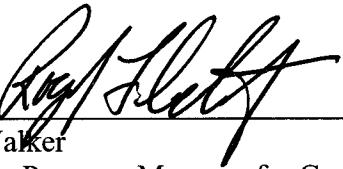
**INTERFACE CONTROL DOCUMENT  
BETWEEN THE  
DEMAND ACCESS SYSTEM (DAS)  
AND THE  
DAS CUSTOMERS**

Original

**15 August 2001**

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15 August 2001

453-ICD-DAS/Customer  
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## Preface

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The purpose of this document is to provide the interface requirements between the Demand Access System (DAS) and DAS Customers to be implemented at the White Sands Ground Terminal (WSGT) and at the Guam Remote Ground Terminal (GRGT).

This document is under the configuration management of the Network and Mission Services Program Configuration Control Board (CCB).

This document may be updated by Documentation Control Notices (DCN) or revision.

Direct all comments, questions, or suggestions regarding this document to:

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# Change Information Page

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List of Effective Pages	
Page Number	Issue
1-1 through 1-2	Original
2-1 through 2-2	Original
3-1 through 3-6	Original
4-1 through 4-2	Original
A-1 through A-32	Original
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# DCN Control Sheet

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DCN Number	Date/Time Group	Month/Year	Section(s) Affected	Initials

# Table of Contents

---

<b>PREFACE .....</b>	<b>III</b>
<b>CHANGE INFORMATION PAGE .....</b>	<b>IV</b>
<b>DCN CONTROL SHEET.....</b>	<b>V</b>
<b>TABLE OF CONTENTS.....</b>	<b>VI</b>
<b>LIST OF FIGURES .....</b>	<b>VIII</b>
<b>LIST OF FIGURES .....</b>	<b>VIII</b>
<b>LIST OF TABLES .....</b>	<b>IX</b>
<b>SECTION 1. INTRODUCTION .....</b>	<b>1-1</b>
1.1    PURPOSE .....	1-1
1.2    SCOPE.....	1-1
<b>SECTION 2. DOCUMENTS.....</b>	<b>2-1</b>
2.1    GENERAL .....	2-1
2.2    APPLICABLE DOCUMENTS .....	2-1
2.3    REFERENCE DOCUMENTS .....	2-1
<b>SECTION 3. INTERFACE DESCRIPTION .....</b>	<b>3-1</b>
3.1    GENERAL .....	3-1
3.2    DAS TO NISN CLOSED IONET INTERFACE .....	3-4
3.2.1 <i>Nominal Operations</i> .....	3-4
3.2.2 <i>TCP/IP Connectivity</i> .....	3-5
3.2.3 <i>TCP Port Assignments</i> .....	3-5
3.2.3.1    IP Addresses .....	3-5
3.2.4 <i>DAS to NISN Closed IONet Interface at WSGT</i> .....	3-5
3.3    DAS LOCAL INTERFACE (LI) DESCRIPTION .....	3-6
3.3.1 <i>TCP/IP Connectivity</i> .....	3-6
3.3.1.1    TCP Port Assignments .....	3-6
3.3.1.2    IP Addresses .....	3-6
3.3.2 <i>WSGT DAS Local Interface</i> .....	3-6
3.3.3 <i>GRGT DAS Local Interface</i> .....	3-6
<b>SECTION 4. INTERFACE REQUIREMENTS .....</b>	<b>4-1</b>
4.1    GENERAL .....	4-1
4.2    DAS TO NISN INTERFACE REQUIREMENTS .....	4-1
4.2.1 <i>DAS Service Data Contents</i> .....	4-1
4.2.2 <i>DAS Protocol</i> .....	4-1
4.2.3 <i>DAS Services Periodicity</i> .....	4-1
4.2.3.1    DAS Services Format.....	4-1
4.2.4 <i>DAS to NISN Closed IONet Interface Requirements at WSGT</i> .....	4-1
4.2.4.1    Point of Demarcation .....	4-1

4.2.4.2	<i>Physical Interface</i>	4-1
4.3	<i>DAS TO LI'S REQUIREMENTS</i>	4-2
4.3.1	<i>DAS Service Data Contents</i>	4-2
4.3.2	<i>DAS Protocol</i>	4-2
4.3.3	<i>DAS Services Periodicity</i>	4-2
4.3.4	<i>DAS Services Format</i>	4-2
4.3.5	<i>WSGT DAS LI</i>	4-2
4.3.5.1	Point of Demarcation	4-2
4.3.5.2	Physical Interface	4-2
4.3.6	<i>GRGT DAS LI</i>	4-2
4.3.6.1	Point of Demarcation	4-2
4.3.6.2	Physical Interface	4-2
<b>APPENDIX A: GROUND TRANSPORT HEADERS .....</b>		<b>A-1</b>
A.1	<i>GENERAL</i>	A-1
A.2	<i>GROUND PROCESSING AND HEADER ENCAPSULATION BACKGROUND</i>	A-1
A.2.1	<i>Frame Synchronization</i>	A-3
A.2.1.1	CCSDS Virtual Channel Processing (VCP)	A-4
A.3	<i>GROUND TRANSPORT HEADER FORMATS</i>	A-5
A.3.1	<i>SFDU Header</i>	A-5
A.3.1.1	General	A-5
A.3.1.2	SFDU Service Request Restrictions	A-5
A.3.1.3	SFDU PTP Process	A-6
A.3.1.4	Telemetry SFDU Header Layout	A-6
A.3.2	<i>AXAF-I Header</i>	A-13
A.3.2.1	General	A-13
A.3.2.2	AXAF-I Service Request Restrictions	A-13
A.3.2.3	AXAF-I PTP Process	A-13
A.3.2.4	AXAF-I SFDU Header Layout	A-14
A.3.3	<i>ACE Header</i>	A-20
A.3.3.1	General	A-20
A.3.3.2	ACE Service Request Restrictions	A-20
A.3.3.3	ACE PTP Process	A-20
A.3.3.4	ACE SFDU Header Layout	A-21
A.3.4	<i>Low Earth Orbit – Terminal (LEO-T) Transport Header</i>	A-27
A.3.4.1	General	A-27
A.3.4.2	LEO-T Service Request Restrictions	A-27
A.3.4.3	LEO-T PTP Process	A-27
A.3.4.4	LEO-T Transport Header Layout	A-27
A.3.5	<i>IPDU Header</i>	A-29
A.3.5.1	General	A-29
A.3.5.2	IPDU Service Request Restrictions	A-29
A.3.5.3	IPDU PTP Process	A-30
A.3.5.4	IPDU Header Layout	A-30
<b>ABBREVIATIONS AND ACRONYMS .....</b>		<b>AB-1</b>

# List of Figures

---

Figure 3-1: Representative DAS to DAS Customer Interfaces through NISN.....	3-1
Figure 3-2: DAS Configuration at WSGT .....	3-2
Figure 3-3: DAS Configuration at GRT .....	3-3
Figure 3-4: DAS-NISN AND Local Interface Configuration.....	3-4
Figure A.1-1: DAS Telemetry Transmission Without Processing or Encapsulation .....	A-1
Figure A.2-1: Typical DAS Telemetry Processing Flow .....	A-2
Figure A.3-1: Typical PTP Process for SFDU Encapsulation Only.....	A-6
Figure A.3-2: Physical Layout of the Telemetry SFDU .....	A-7
Figure A.3-3: Telemetry SFDU Label Physical Layout.....	A-8
Figure A.3-4: Telemetry SFDU Header Aggregation CHDO Label Physical Layout .....	A-9
Figure A.3-5: Telemetry SFDU Primary Header CHDO Label Physical Layout .....	A-9
Figure A.3-6: Telemetry SFDU Secondary Header CHDO Label Physical Layout .....	A-10
Figure A.3-7: Telemetry SFDU Telemetry CHDO Label Physical Layout .....	A-13
Figure A.3-8: Typical PTP Process for AXAF-I SFDU Encapsulation .....	A-14
Figure A.3-9: Telemetry AXAF-I SFDU Physical Layout.....	A-14
Figure A.3-10: AXAF-I Telemetry SFDU Label Physical Layout.....	A-15
Figure A.3-11: AXAF-I Header Aggregation CHDO Label Physical Layout .....	A-16
Figure A.3-12: AXAF-I Primary Header CHDO Label Physical Layout .....	A-16
Figure A.3-13: AXAF-I Secondary Header CHDO Label Physical Layout .....	A-17
Figure A.3-14: AXAF-I Telemetry Data CHDO Label Physical Layout.....	A-20
Figure A.3-15: Typical PTP Process for ACE Virtual Channel Framing, Segregation and SFDU Encapsulation .....	A-21
Figure A.3-16: ACE SFDU Layout Physical Layout .....	A-21
Figure A.3-17: ACE Telemetry SFDU Label Physical Layout .....	A-22
Figure A.3-18: ACE SFDU Header Aggregation CHDO Label Physical Layout.....	A-23
Figure A.3-19: ACE Primary Header CHDO Label Physical Layout.....	A-23
Figure A.3-20: ACE Secondary Header CHDO Label Physical Layout .....	A-24
Figure A.3-21: ACE Telemetry Data CHDO Label Physical Layout .....	A-26
Figure A.3-22: Typical PTP Process for LEO-T Header Encapsulation .....	A-27
Figure A.3-23: LEO-T Header Physical Layout.....	A-28
Figure A.3-24: Typical PTP Process for IPDU Header Encapsulation .....	A-30
Figure A.3-25: IPDU Header Physical Layout.....	A-30

# List of Tables

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Table 3-1: DAS PTP Service Configuration Parameters .....	3-5
Table A.2-1: Application Level Protocols for DAS Services.....	A-2
Table A.3-1: Telemetry SFDU Label Field Descriptions.....	A-8
Table A.3-2: SFDU Header Fields Originating Source Definitions .....	A-8
Table A.3-3: Telemetry SFDU Header Aggregation CHDO Label Field Descriptions .....	A-9
Table A.3-4: Telemetry SFDU Primary Header CHDO Label Field Descriptions .....	A-10
Table A.3-5: Telemetry SFDU Secondary Header CHDO Label Field Descriptions .....	A-11
Table A.3-6: Telemetry SFDU Telemetry CHDO Label Field Descriptions .....	A-13
Table A.3-7: AXAF-I Telemetry SFDU Label Field Descriptions .....	A-15
Table A.3-8: AXAF-I SFDU Header Fields Originating Source Definitions .....	A-15
Table A.3-9: AXAF-I Header Aggregation CHDO Field Descriptions .....	A-16
Table A.3-10: AXAF-I Primary Header CHDO Label Field Descriptions .....	A-16
Table A.3-11: AXAF-I Secondary Header CHDO Label Field Descriptions .....	A-18
Table A.3-12: AXAF-I Telemetry CHDO Label Field Descriptions .....	A-20
Table A.3-13: ACE Telemetry SFDU Label Field Descriptions .....	A-22
Table A.3-14: ACE Telemetry SFDU Header Fields Originating Source Definitions.....	A-22
Table A.3-15: ACE SFDU Header Aggregation CHDO Label Field Descriptions.....	A-23
Table A.3-16: ACE Primary Header CHDO Label Field Descriptions.....	A-23
Table A.3-17: ACE Secondary Header CHDO Label Field Descriptions.....	A-25
Table A.3-18: ACE Telemetry Data CHDO Label Field Descriptions .....	A-27
Table A.3-19: LEO-T Header Field Descriptions .....	A-28
Table A.3-20: LEO-T Header Fields Originating Source Definitions.....	A-29
Table A.3-21: IPDU Header Field Descriptions.....	A-31
Table A.3-22: IPDU Header Fields Originating Source Definitions.....	A-32

# **Section 1. Introduction**

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## **1.1 Purpose**

The purpose of this Interface Control Document (ICD) is to define the interface requirements for the formatting and delivery of mission data from the Demand Access System (DAS) to DAS Customers, as specified by the DAS System Requirements Document, 453-SRD-DAS.

The DAS Customer specifies the format and delivery destination of mission telemetry data as part of the DAS service request through the Space Network Web Services Interface (SWSI). This request must include certain information: a) the mission-specific values of certain parameters (e.g., the spacecraft identifier), b) mission-specific choices on certain processing options (e.g., whether the physical telemetry data is to be formatted and routed as a single sequence of packets or split by virtual channels into multiple sequences of packets); and c) where the resultant formatted ground transport stream is to be delivered (e.g., either to a local DAS interface point for pickup by the Customer or to the DAS NASA Integrated Services Network (NISN) interface point for delivery to the Customer).

## **1.2 Scope**

The scope of this ICD is to define the networking and physical interfaces between DAS and telecommunications transport systems that DAS Customers select to transport mission data from DAS to locations specified by each Customer. DAS Customers may choose to receive Transmission Control Protocol/Internet Protocol (TCP/IP) formatted mission data from DAS either through the NISN Internet Protocol Operational Network (IONet) or through a Local Interface (LI) at the WSGT or the GRGT.

Appendix A of this document also defines the options within DAS to process and format Customer telemetry data for ground transport. Options include:

- The Consultative Committee for Space Data Systems (CCSDS) Standard Formatted Data Unit (SFDU) used to provide a standardized and internationally recognized methodology for information exchange,
- The CCSDS fixed-length Virtual Channel Data Units (VCDU) used by the Advanced X-ray Astrophysics Facility-Imagery (AXAF-I) spacecraft,
- The CCSDS fixed-length transfer frames used by the Advanced Composition Explorer (ACE) spacecraft,
- The Low Earth Orbiting-Terminal (LEO-T) Telemetry Frame Delivery Header (TFDH), and
- The NASA Internet Protocol Data Unit (IPDU).

Two additional ICD's address other DAS interfaces: the Interface Control Document between the DAS and the WSC, 453-ICD-DAS/WSC, defines the interfaces between DAS and the

systems at WSC; and the Interface Control Document between the DAS and the SWSI, 453-ICD-DAS/SWSI, defines the interfaces between DAS and the SWSI.

## **Section 2. Documents**

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### **2.1 General**

Section 2.2 lists the documents that are part of this ICD to the extent cited therein. Section 2.3 lists documents that serve as references for supplemental descriptive information. The most recent version of these documents takes precedence. If there are conflicts between the listed documents and the requirements of this ICD, the requirements of this ICD take precedence. If no section number is shown, the whole document applies.

### **2.2 Applicable Documents**

<u>Document Number</u>	<u>Document Title</u>
453-SRD-DAS	DAS System Requirements Document
453-ICD-DAS/SWSI	Interface Control Document between the Demand Access System (DAS) and the Space Network Web Services Interface (SWSI)
453-ICD-DAS/WSC	Interface Control Document between the Demand Access System (DAS) and the White Sands Complex (WSC)
NPG 2810.1	NASA Procedures and Guidelines, (NPG) 2810.1, Security of Information Technology
290-004	IONet Access Protection Policy and Requirements Document
290-003	IONet Security Plan
IEEE Std. 802.3	IEEE Standard for Information Technology-Local and Metropolitan Network-Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications

### **2.3 Reference Documents**

<u>Document Number</u>	<u>Document Title</u>
453-OCD-DAS	DAS Operations Concept Document

15 August 2001                    2-1                    453-ICD-DAS/Customer Original

451-WDISC-SSD-98	WSC Transmission Control Protocol (TCP)/Internet Protocol (IP) Data Interface Service Capability (WDISC) Service Specification
530-ICD-NCCDS/MOC	Interface Control Document (ICD) between the Network Control Center (NCC) and the Mission Operations Centers
530-SNUG	Space Network User's Guide
DSN 830-013 TLM-3-29	Telemetry Standard Formatted Data Unit (SFDU) Interface
DSN 830-013 TLM-3-26	Deep Space Network (DSN) Telemetry Interface with Marshall Space Flight Center (MSFC) for the Advanced X-ray Astrophysics Facility-Imaging (AXAF-I) Project
DSN 830-013 TLM-3-27	DSN Telemetry Interface with the Advanced Composition Explorer (ACE)
430-14-01-001-0	Interface Control Document between LANDSAT-7 and LANDSAT-7 Ground Network (LGN), Appendix C
CCSDS 102.0-B-3	Packet Telemetry. Recommendation for Space Data Systems Standards
CCSDS 101.0-B-3	Telemetry Channel Coding. Recommendation for Space Data Systems Standards
CCSDS 103.0-B-1	Packet Telemetry Services. Draft Recommendation for Space Data Systems Standards
	Epoch2000 LEO-T Operations and Maintenance Manual, Release 1.7, undated. Prepared by Integral Systems, Inc
IETF RFC 793	Transmission Control Protocol DARPA Internet Program Protocol Specification
IETF RFC 791	Internet Protocol DARPA Internet Program Protocol Specification
IETF RFC 826	An Ethernet Address Resolution Protocol for Converting Network Protocol Addresses to 48 bit Ethernet Addresses for Transmission on Ethernet Hardware

## Section 3. Interface Description

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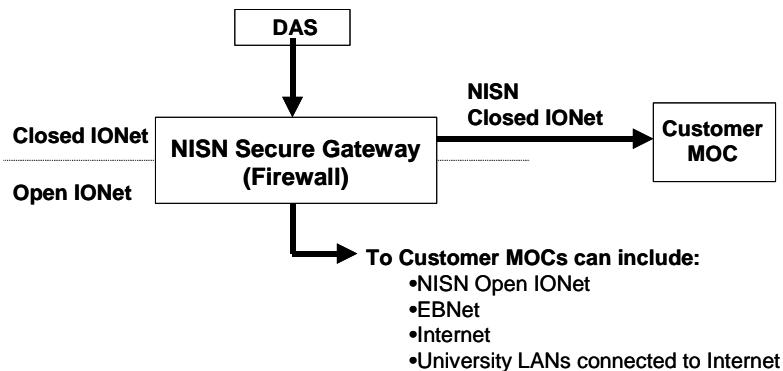
### 3.1 General

The following interfaces comprise the DAS to DAS Customer interface:

- DAS to NISN Closed IONet Interface and
- DAS Local Interface (LI) to selected Customers

DAS transmits all CCSDS-formatted and unformatted telemetry data over the NISN or LI's in standard TCP/IP protocol packets. One TCP/IP socket connection will be provided for each return telemetry data or playback service requested by the Customer. Optional ground transport header formats are supported by the DAS Programmable Telemetry Processors (PTP's), and the various formats are described in Appendix A. Therein, elements of the header format fields requiring inputs from Customers are described, and the means for data entry of these fields through SWSI Customer terminal screens is specified in the ICD between the DAS and the SWSI, 453-ICD-DAS/SWSI.

Except for Customers with LI connections at WSGT or GRGT, DAS will use the NISN Closed IONet to deliver service data to Customers through the NISN secure gateway to their Mission Operations Center (MOC). Closed IONet supports the transport of return and archived data from DAS to the Customer and also supports the transport of TCP control and status from the Customer to DAS. As shown in Figure 3-1, representative MOC locations can include the NISN Closed IONet, NISN Open IONet, Earth Observation System (EOS) Backbone Network (EBNet), NASA Internet, the Internet, or a University Local Area Network (LAN) on the Internet.



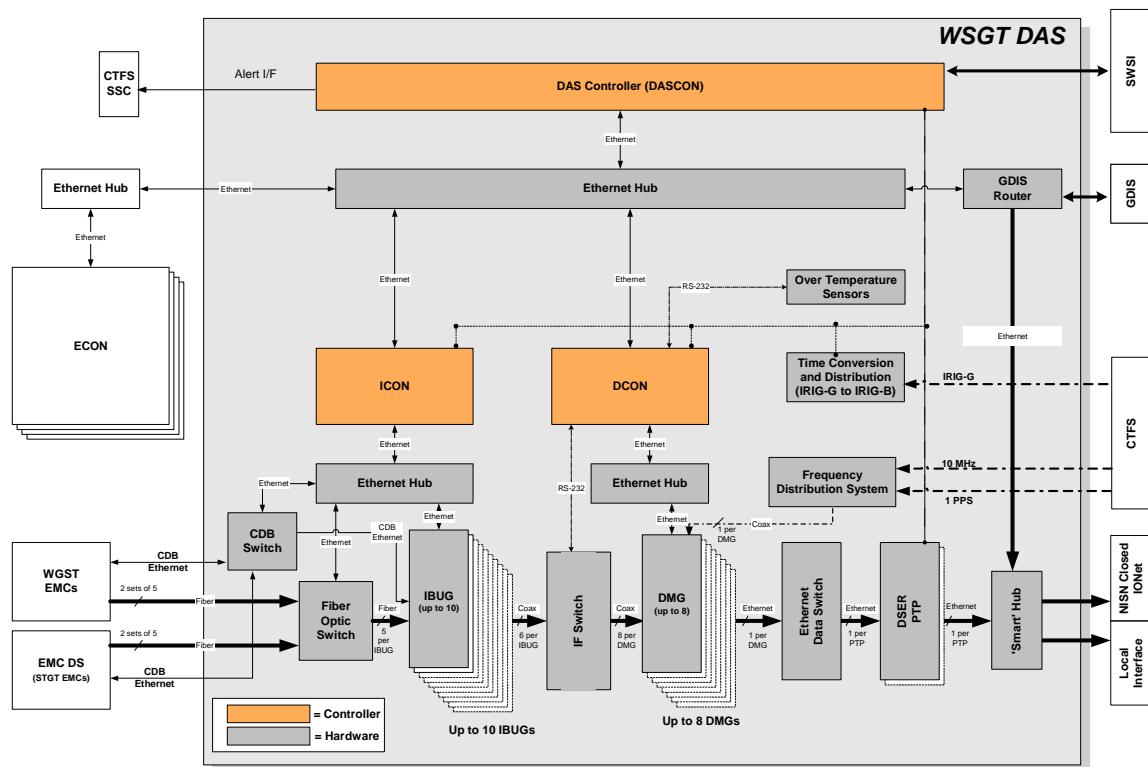
**Figure 3-1: Representative DAS to DAS Customer Interfaces through NISN**

DAS provides equipment at both WSGT and GRGT to process assigned Tracking and Data Relay Satellite (TDRS) Multiple Access Return (MAR) signals. For the DAS to NISN interface, DAS shall comply with the provisions of the IONet Access Protection Policy and Requirements Document, 290-004, and shall implement appropriate security protocols to ensure compliance with the NASA Procedures and Guidelines for Security of Information Technology for Mission

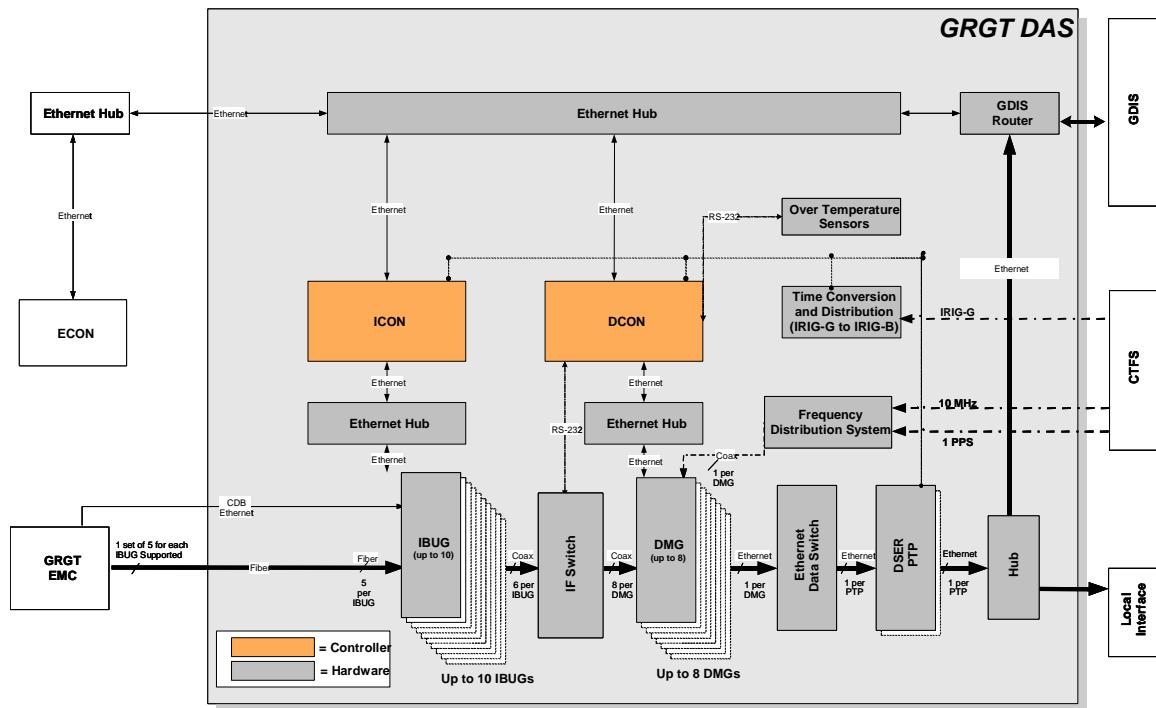
Information, NPG 2810.1.

Figures 3-2 and 3-3 illustrate the configuration of DAS at WSGT and GRGT, respectively. Note that DAS at GRGT operates under the command of the DAS Controller (DASCON) at WSGT.

In general, the Customer's emitter transmits telemetry data to the designated TDRS as specified in the DAS Customer service request input through SWSI. The TDRS downlinks the Customer data through a WSGT or GRGT Space Ground Link Terminal (SGLT) and the Element Multiplexer Correlator (EMC) either to the DAS at GRGT or WSGT. After beamforming of the signal at WSGT or GRGT, a DAS PTP receives the data from a DAS receiver/demodulator(s), frame-syncs the data, and performs processing on the data. The data is archived and, if requested, sent in real-time to the Customer MOC via a TCP/IP connection. Figure 3-4 provides an overview of the DAS to NISN and DAS to LI connections. The DAS at GRGT routes Customer TCP/IP data over a single line through the Guam Data Interface System (GDIS) to the DAS at WSGT, or it sends the data to a Customer LI at GRGT. LI data at GRGT is also available at WSGT.



**Figure 3-2: DAS Configuration at WSGT**

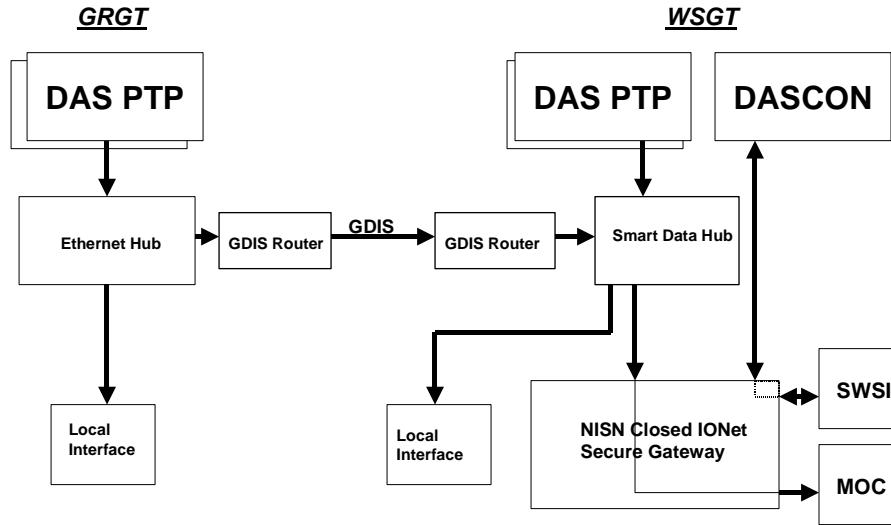


**Figure 3-3: DAS Configuration at GRGT**

The GDIS interface is comprised of two T-1 multiplexers that are specially configured to handle data traffic between WSGT and GRGT. The GDIS has the unique capability of having data buffers and remote clock sense and generation that allow Customers of the GDIS system to use it with synchronous and asynchronous data at virtually any data rate.

The DAS interface to the GDIS will be provided through an Ethernet router. This router is installed in the GDIS racks at both WSGT and GRGT, and interface to DAS via Ethernet connections. The DAS control, status, and data are sent bi-directionally over the link via the RS-422 interface associated with the GDIS. The specifics of the DAS to GDIS interface are described in the ICD between the DAS and WSC, 453-ICD-DAS/WSC.

When data is received from GRGT at WSGT, it is further routed to the Customer through the NISN Closed IONet. Similarly, DAS output data at WSGT is either switched to a WSGT LI or to the NISN Closed IONet secure gateway for further transport to the Customer MOC. The smart data hub at WSGT is an Ethernet switch, which prevents any LI Customer data from inadvertently being sent over the NISN Closed IONet.



**Figure 3-4: DAS-NISN AND Local Interface Configuration**

## 3.2 DAS to NISN Closed IONet Interface

TCP/IP client/server relationships are established on a Customer-by-Customer basis by NASA. The preferred method is to configure the PTP as the TCP client so that the PTP initiates the socket connection at the time that the Customer return data services are scheduled to begin. The Customer side of the TCP/IP connection is expected to be ready to receive return data from the PTP based on the IP address and TCP port number provided to DAS in the Service Specification Code (SSC) parameters associated with the Customer service request.

### 3.2.1 Nominal Operations

The Customer MOC is responsible for the following in a DAS nominal operational scenario:

- Requesting DAS services through SWSI nominally any time prior to two minutes before the start of services. DAS may support services requested up to 30 seconds prior to service initiation, if necessary.
- Receiving service request responses from DAS through SWSI indicating that DAS resources are available and line-of-sight visibility with requested TDRS(s) has been confirmed.
- Establishing a TCP socket connection with the appropriate DAS PTP at the addresses indicated, using a mission-specific data port number.
- Receiving either MAR data or playback service data throughout the scheduled support period.
- Disconnecting the TCP socket connection when all service data has been received from the PTP.

### **3.2.2 TCP/IP Connectivity**

The DAS PTP initiates all TCP/IP connections to DAS Customers from the Closed IONet side of the NISN secure gateway. At service start, the DAS PTP initiates the TCP socket connection by performing an ACTIVE OPEN command with the operating system. Similarly, the DAS Customer terminal performs a PASSIVE OPEN function by contacting its operating system and indicating that it will accept an incoming connection being initiated by the DAS PTP.

### **3.2.3 TCP Port Assignments**

Each PTP desktop, a PTP configuration file that defines and controls the capabilities of one PTP service, has an output socket module associated with each MAR and playback data service. The output socket module provides TCP/IP encapsulation of data, and it establishes a socket connection using a mission service specific TCP port number. The PTP TCP port number is provided to the Customer destination terminal during the setup of the TCP connection. Representative TCP port numbers are contained in Table 3-1.

**Table 3-1: DAS PTP Service Configuration Parameters**

Service	TCP Interface Port		Domain Name XXXXXX.ops.nascom.nasa.gov
	Port#	PTP Identifier	
Return	6000-6099	WSGT-DAS-PTP1	XXXXXX = wdptp1
	6100-6199	WSGT-DAS-PTP2	XXXXXX = wdptp2
	6200-6299	GRGT-DAS-PTP1	XXXXXX = gdptp1
	6300-6399	GRGT-DAS-PTP2	XXXXXX = gdptp2
Playback	7000-7099	WSGT-DAS-PTP1	XXXXXX = wdptp1
	7100-7199	WSGT-DAS-PTP2	XXXXXX = wdptp2
	7200-7299	GRGT-DAS-PTP1	XXXXXX = gdptp1
	7300-7399	GRGT-DAS-PTP2	XXXXXX = gdptp2

#### **3.2.3.1 IP Addresses**

IP addresses are obtained by resolving server aliases, i.e., domain names, to IP addresses. NISN operates a Domain Name System (DNS) server supporting PTP server aliases to permit a Customer's DNS name resolver to perform this service. Table 3-1 lists the aliases for each PTP located at WSGT and GRGT.

### **3.2.4 DAS to NISN Closed IONet Interface at WSGT**

DAS provides a PTP at WSGT that supports transporting real-time and/or archived telemetry to multiple DAS Customers through the NISN Closed IONet secure gateway. DAS connectivity to the gateway is supported through a smart data hub Ethernet switch.

DAS provides a PTP at GRGT that supports transporting real-time and/or archived telemetry to WSGT, where the data is routed to multiple DAS Customers through the NISN Closed IONet Secure Gateway. From GRGT, the DAS PTP connects through the GDIS over a single line to the WSGT GDIS router. DAS ensures the GDIS bandwidth allocations established for DAS will not be exceeded. The GDIS router at WSGT routes all DAS service packets received from GRGT to the NISN secure gateway through a smart data hub Ethernet switch.

NISN closed IONet connectivity to the DAS Customer destination beyond the gateway is a Customer responsibility requiring coordination with NISN. DAS PTP's comply with the NISN requirements for accessing the secure gateway firewall.

### **3.3 DAS Local Interface (LI) Description**

Customers who elect to receive DAS services locally, within the security perimeter of the WSGT or GRGT facilities, may do so by providing their own interface at these locations.

#### **3.3.1 TCP/IP Connectivity**

At service start, the DAS PTP initiates all TCP/IP connections through an ACTIVE OPEN command to DAS Customer LI terminals. A LI Customer terminal performs a TCP PASSIVE OPEN function by contacting its operating system and indicating that it will accept an incoming connection.

##### **3.3.1.1 TCP Port Assignments**

The PTP desktop output socket module provides TCP/IP encapsulation of data, and it establishes a socket connection using a mission service specific TCP port number. The PTP TCP port number is provided to the Customer LI terminal during the setup of a TCP connection. Representative TCP port numbers are contained in Table 3-1.

##### **3.3.1.2 IP Addresses**

Numerical IP addresses for LI terminals shall be provided during the initial setup of the DAS services. Domain name resolution of IP aliases is not available for LI connections.

#### **3.3.2 WSGT DAS Local Interface**

DAS provides smart data hub (Ethernet switch) ports to support LI Customer requirements at WSGT. The current smart data hub configuration will support up to six (6) LI port connections without additional hardware for fan-out.

#### **3.3.3 GRGT DAS Local Interface**

DAS shall provide Ethernet hub ports to support local interface Customer requirements at GRGT. The current hub configuration will support up to eight (8) LI ports without additional hardware for fan-out.

## **Section 4. Interface Requirements**

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### **4.1 General**

Section 4 specifies the requirements for the following two (2) interfaces:

- DAS to NISN Interface
- DAS to Local Interface

### **4.2 DAS to NISN Interface Requirements**

4.2.a DAS shall interface with the NISN Closed IONet at WSGT.

4.2.b Return telemetry and playback service data coming from GRGT shall be transported over the GDIS to WSGT for further routing to Customer MOCs through the NISN Closed IONet interface at WSGT.

4.2.c DAS service data coming from GRGT shall interface with the NISN in the identical manner as DAS service data from WSGT.

#### **4.2.1 DAS Service Data Contents**

4.2.1.a DAS data traffic shall consist of MAR data.

4.2.1.b DAS data traffic shall consist of playback service data.

#### **4.2.2 DAS Protocol**

4.2.2.a DAS shall utilize TCP/IP for the interface protocol.

#### **4.2.3 DAS Services Periodicity**

4.2.3.a DAS shall transmit MAR data in accordance with a Customer service request.

4.2.3.b DAS shall transmit playback service data in accordance with a Customer service request.

#### **4.2.3.1 DAS Services Format**

4.2.3.1.a DAS services shall support non-CCSDS and CCSDS-formatted data, as described in Appendix A of this ICD.

#### **4.2.4 DAS to NISN Closed IONet Interface Requirements at WSGT**

##### **4.2.4.1 Point of Demarcation**

4.2.4.1.a The point of service demarcation for the DAS at WSGT shall be at the input to the LAN interface of the NISN Wide Area Network (WAN) Router.

##### **4.2.4.2 Physical Interface**

4.2.4.2.a The DAS physical interfaces to the NISN WAN router shall be as specified in IEEE Std. 802.3.

## **4.3 DAS to LI's Requirements**

- 4.3.a DAS shall support Customer LI connections at WSGT.
- 4.3.b DAS shall support Customer LI connections at GRGT.
- 4.3.c DAS shall transmit the GRGT LI service data to the LI at WSGT.

### **4.3.1 DAS Service Data Contents**

- 4.3.1.a DAS data traffic shall consist of MAR data.
- 4.3.1.b DAS data traffic shall consist of playback service data.

### **4.3.2 DAS Protocol**

- 4.3.2.a DAS shall utilize TCP/IP for the interface protocol.

### **4.3.3 DAS Services Periodicity**

- 4.3.3.a DAS shall transmit MAR data in accordance with a Customer service request.
- 4.3.3.b DAS shall transmit playback service data in accordance with a Customer service request.

### **4.3.4 DAS Services Format**

- 4.3.4.a DAS Services shall support non-CCSDS and CCSDS-formatted data as described in Appendix A of this ICD.

## **4.3.5 WSGT DAS LI**

### **4.3.5.1 Point of Demarcation**

- 4.3.5.1.a The point of service demarcation for DAS WSGT LI shall be at the output of the assigned LI port of the smart data hub.

### **4.3.5.2 Physical Interface**

- 4.3.5.2.a The DAS physical interface to the DAS smart data hub shall be as specified in IEEE Std. 802.3.

## **4.3.6 GRGT DAS LI**

### **4.3.6.1 Point of Demarcation**

- 4.3.6.1.a The point of service demarcation for the DAS GRGT LI shall be at the output of the assigned LI port interface of the DAS distribution Ethernet hub.

### **4.3.6.2 Physical Interface**

- 4.3.6.2.a The DAS physical interface to the DAS Ethernet hub shall be as specified in IEEE Std. 802.3.

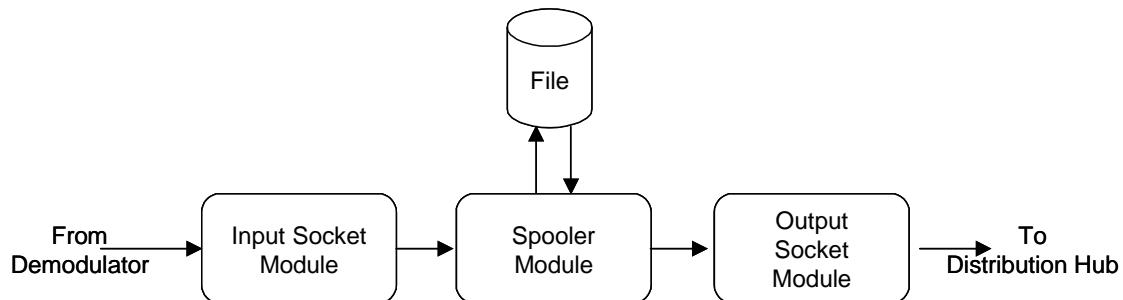
## APPENDIX A: Ground Transport Headers

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### A.1 General

DAS transmits Customer telemetry without any CCSDS processing or encapsulation in any structured header other than the normal TCP/IP transmission structures unless otherwise specified by the Customer in a service request. The PTP's are still used, however, no signal or encapsulation processing is applied. Rather, the PTP is used to simply archive the data and to stream it as TCP/IP packets for delivery as illustrated in Figure A.1-1.

DAS provides telemetry data with the least manipulation for Customers with their own PTP's. In addition, with TCP/IP reliability, this method provides the highest assurance that the data received via NISN is exactly as the data received by the DAS demodulator.



**Figure A.1-1: DAS Telemetry Transmission Without Processing or Encapsulation**

### A.2 Ground Processing and Header Encapsulation Background

All application-level interfaces (above the TCP transport layer) are supported through TCP socket connections that are associated with a particular PTP desktop, the configuration file that defines and controls the capabilities of one PTP service.

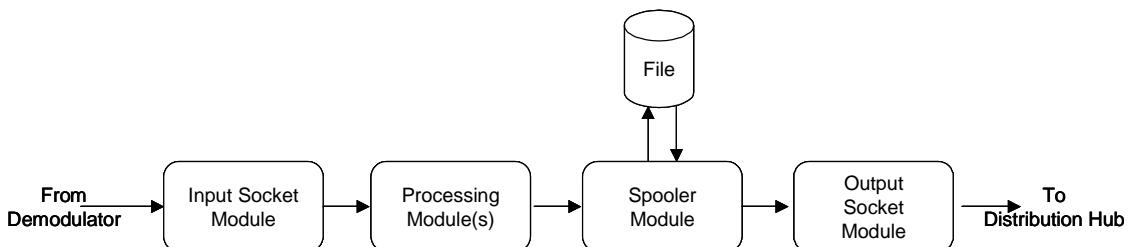
DAS PTP's are compatible with specific CCSDS data formats and other ground transport headers are optional for space link communications. The ground transport headers supported are the Standard Formatted Data Unit (SFDU), Advanced X-ray Astrophysics Facility – Imagery (AXAF-I), Advanced Composition Explorer (ACE), Low Earth Orbit-Terminal (LEO-T), and the IP Data Unit (IPDU). Application-level protocols are summarized in Table A.2-1. Without the optional ground transport headers, DAS provides MAR or playback services as asynchronous data streams encapsulated with TCP/IP protocols.

**Table A.2-1: Application Level Protocols for DAS Services**

Interface Type	Space Link Format	Ground Transport Header	Content
Return Data (Baseline Default)	N/A	Asynchronous None - TCP/IP only	Return telemetry
Return Data	CCSDS	SFDU	Return telemetry with SFDU header
Return Data	CCSDS	AXAF-I	Return telemetry with AXAF-I header
Return Data	CCSDS	ACE	Return telemetry with ACE header
Return Data	NASA	LEO-T	Return telemetry with LEO-T header
Return Data	NASA	IPDU	Return telemetry with status header
Playback Data	N/A	None- TCP/IP only	Files of archived data

DAS supports telemetry processing in order to properly frame the data, encapsulate it for ground transport by NISN or pick up by the Customer at the LI. DAS will automatically establish the PTP processing desktop based on the processing services requested in the DAS service request. The service request SSC parameters are specified in the ICD between the DAS and the SWSI, 453-ICD-DAS/SWSI.

A typical DAS desktop is illustrated in Figure A.2-1. Typically, four or more PTP processing modules are established: (1) an input module to receive the telemetry packet stream from the DAS demodulators, (2) one or more modules to frame and encapsulate the telemetry for transport, (3) a data recording spooler module to archive the encapsulated telemetry, and (4) an output TCP/IP module to pass the encapsulated telemetry to the LI or to the NISN Closed IONet for delivery to the Customer.



**Figure A.2-1: Typical DAS Telemetry Processing Flow**

The physical telemetry channel is typically formatted as a stream of fixed length frames with an attached marker. A frame is a bit string, often several thousand bits long. An attached marker is a bit string of fixed length and of a known, fixed pattern. The DAS PTP's are capable of recognizing and delimiting frames if the spacecraft telemetry conforms to CCSDS recommendations on synchronization.

Spacecraft conforming to the CCSDS recommendation on packet telemetry use a transfer frame;

others conforming to the CCSDS recommendation on advanced orbiting systems use a virtual channel data unit (VCDU) frame or a coded virtual channel data unit (CVCDU) frame. Transfer frames, VCDU's and CVCDU's all have a well-defined primary-header, which enables the DAS PTP's to distinguish frame type (transfer or VCDU/CVCDU) and to determine the spacecraft identifier. DAS is capable of processing virtual channels in varying ways, e.g., delivering different virtual channel streams to different destinations.

Spacecraft telemetry not conforming to CCSDS recommendations on synchronization and frame structure cannot use the advanced DAS processing capabilities inherent in the PTP's. In this case, DAS demodulates the physical channel, decodes it (if encoded using the standard convolutional encoding scheme), and encapsulates it as a series of IP data grams over a TCP connection.

The DAS PTP processes and segregates CCSDS virtual channels. It filters frames based on channel identification (ID) and outputs all or just acceptable frames to differing destinations based on routing data contained in the uncoded channel headers. The DAS PTP identifies Version 1 transfer frames and Version 2 channel access data units. DAS PTP's contain software-based Cyclic Redundancy Check (CRC) and Reed-Solomon (RS) decoders.

DAS implements frame synch and CCSDS Virtual Channel Processor (VCP) PTP telemetry processing modules as described in remaining sections of Appendix A.2.

### A.2.1 Frame Synchronization

The DAS frame sync module accepts a stream of data and frame synchronizes it. This processing must be requested whenever the Customer requests any CCSDS process or SFDU, AXAF-I or ACE header encapsulation process in the service request. This processing may be requested whenever the Customer requests frame synchronization and LEO-T or IPDU header encapsulation

If the Customer requests CCSDS processing or header encapsulation, the Customer must provide the following:

Frame Length. Customers must specify the expected frame length in bytes. DAS will accept frame lengths from 8 to 60,000 bytes. Bits are inserted into a shift register, one at a time, until the Customer-defined sync marker is found to achieve lock based on the Customer-specified error tolerance. Once lock is achieved, the bits are copied to a new buffer to be output as a frame of the Customer-specified length or, in the case of variable length frames that include the last bit immediately prior to the start of the next sync pattern.

Sync Pattern. Customers must specify a sync pattern that is eight hexadecimal digits (32 bits) in length. All eight digits must be entered, even if they are zero. The actual digits used are defined by the mask pattern. The DAS default pattern is 1ACFFC1D.

Sync Mask Pattern. Customers must specify a sync mask pattern that is eight hexadecimal digits (32 bits) in length. The mask determines which of the sync pattern bits must be matched on the input data. A mask value of one (1) indicates the sync pattern bit must be matched. A mask value of zero (0) indicates the sync pattern bits are to be ignored. The default pattern is

FFFFFFF.

A synchronization threshold is calculated as the number of ones in the mask pattern minus the number of allowable errors defined as:

- Allowable errors in the search threshold. The range is zero (0) to the maximum number of all ones in the mask pattern. By default, DAS will allow zero bit errors in the frame sync marker during frame search.
- Allowable errors in the check and lock threshold. The range is zero (0) to the maximum number of all ones in the mask pattern. By default, DAS will allow zero bit errors in the frame sync marker during frame check and lock.

By default, DAS will allow one (1) frame with one (1) bit error in the sync marker before reinitiating frame search.

Sync marker bit error tolerance (BET) will impact the quality of data received. Set too tight, data will be lost as DAS rejects frames with frame marker errors; set too loose, data may be corrupt as DAS includes frames not properly synchronized. DAS will accept a Customer-specified sync marker bit error tolerance from zero (0) bit errors to the maximum number of all ones in the mask pattern during frame sync search, check and lock operations.

#### **A.2.1.1 CCSDS Virtual Channel Processing (VCP)**

The DAS CCSDS VCP module receives framed data from the super synchronizer module. The VCP provides software CRC and RS decoders. It filters CCSDS frames based on the virtual channel identifier. The VCP maintains a per channel count of frames received, frames with RS errors, frames with uncorrectable RS errors, frames with CRC errors, and frames with sequence errors. Both Version 1 transfer frames and Version 2 channel access data units are supported. The Customer must request this processing in the service request. The Customer must also request the frame super synchronization service as a prerequisite for virtual channel processing.

If the Customer requests CCSDS virtual channel processing, the following parameters apply:

CRC Location. Customer must specify the byte location of the CRC code. Value range is zero (0) to the length of the frame.

CRC Checking. By default, DAS performs a CRC and reports the status of this check in the standard CCSDS ground transport headers.

RS Decoding. By default, DAS does not perform RS decoding unless the Customer request RS decoding in the service request. If the Customer requests RS decoding, the Customer must also provide the RS interleave depth (1 to 8), the location of the RS codeword (byte), and the RS codeword virtual fill (number equals 255 minus actual codeword length in bytes). DAS performs the decoding and reports the status check in the standard CCSDS ground transport headers.

Virtual Channel Segregation. By default, DAS will not segregate housekeeping data (Virtual Channel 00) from engineering data (Virtual Channels 01-63) for distribution to separate destinations unless the Customer requests channel segregation in the service request. If the Customer requests channel segregation and provides a second destination IP address in the service request, DAS will segregate Virtual Channel 00 frames and send them together with the requested encapsulation header to the first IP address in the service request. DAS will send all

remaining virtual channel frames together with the requested encapsulation header to the second IP address in the service request.

## A.3 Ground Transport Header Formats

The DAS will support the following ground transport encapsulation formats for transmission over the NISN Closed IONet:

- The CCSDS SFDU used to provide a standardized and internationally recognized methodology for information exchange,
- The CCSDS fixed-length VCDU used by the AXAF-I spacecraft,
- The CCSDS fixed-length transfer frames used by the ACE spacecraft,
- The LEO-T Telemetry Frame Delivery Header (TFDH), and
- The NASA IPDU developed for LANDSAT-7.

Telemetry that is CCSDS formatted can be framed by the PTP and processed to segregate and group virtual channels. CCSDS frame and channel identification information can be used by the PTP to route the telemetry to specific destinations. A telemetry stream of several intermingled virtual channels can be independently routed on a channel-by-channel basis or segregated and routed to a single destination in channel sequence order.

Each ground transport header format is described in the remainder of Appendix A.3.

### A.3.1 SFDU Header

#### A.3.1.1 General

A telemetry SFDU is a self-identifying, self-delimiting data structure that is used to encapsulate a portion of telemetry data acquired by a ground processing facility from a spacecraft for delivery to other ground facilities. Typically, each SFDU encapsulates one telemetry transfer frame. A given sequence of telemetry SFDU's may encapsulate one physical channel from a spacecraft or it may encapsulate only a portion of the physical channel, such as a virtual channel. Each SFDU also contains additional information related to the encapsulated data, primarily data quality information developed while processing the physical channel.

DAS supports SFDU variants as implemented by the PTP's. The baseline SFDU structure implemented by the PTP is based on the Deep Space Network (DSN) SFDU as defined in Telemetry Standard Formatted Data Unit Interface, DSN-830-013-TLM-3-29. However, for the DAS PTP implementation certain header fields are not implemented as indicated by the Not Applicable (N/A) originating source. DAS delivers telemetry SFDU's to Customers using the TCP/IP.

#### A.3.1.2 SFDU Service Request Restrictions

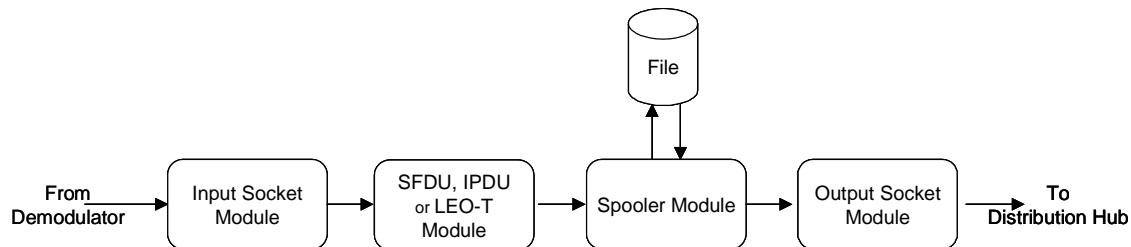
When using this header format, the Customer must specify frame synchronization parameters and may optionally specify virtual channel processing parameters and an optional mission ID number in the service request. DAS will reject any request for this encapsulation header without

a concurrent request for frame synchronization in the service request. DAS will also reject any request for this encapsulation header that includes a concurrent request for virtual channel processing without a concurrent request for frame synchronization in the service request.

The details of the specific Customer service request SSC parameters are provided in the ICD between the DAS and the SWSI, 453-ICD-DAS/SWSI.

### A.3.1.3 SFDU PTP Process

Figure A.3-1 illustrates a typical PTP desktop providing telemetry encapsulation using this SFDU version without any CCSDS processing.



**Figure A.3-1: Typical PTP Process for SFDU Encapsulation Only**

Baseline SFDU formatted telemetry can also be processed for frame alignment and for frame alignment and virtual channel segregation by using desktops similar to those shown below for AXAF-I and ACE.

### A.3.1.4 Telemetry SFDU Header Layout

CCSDS-compliant telemetry acquired by DAS is encapsulated as time-ordered sequences of SFDU's. SFDU's use 16-bit (2-octet) words. Figure A.3-2 illustrates the physical layout.

Word	Bit														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
10	Telemetry SFDU Label (10 Words)														
11	Header Aggregation CHDO Label (2 Words)														
12															
13	Primary Header CHDO Label (4 Words)														
16															
17	Secondary Header CHDO Label (32 Words)														
48															
49	Telemetry Data CHDO Label (N-48 Words)														
N															

**Figure A.3-2: Telemetry SFDU Physical Layout**

The physical layout is divided into five sections: (1) the telemetry SFDU label, (2) the header aggregation Compressed Header Data Object (CHDO) label, (3) the primary header CHDO label, (4) the secondary header CHDO label, and (5) the telemetry data CHDO label. The primary header and secondary header CHDO's constitute the value field of the header aggregation CHDO. Together, the header aggregation and the telemetry data CHDO's constitute value fields of the telemetry SFDU.

Typically, the SFDU is a variable length structure. The length of the SFDU is determined by the length attribute in the SFDU label. The only part of the telemetry SFDU that is variable in length is the telemetry data CHDO.

#### A.3.1.4.1 Telemetry SFDU Label

Words 1 through 10 of the telemetry SFDU contain the telemetry SFDU label whose physical layout is illustrated in Figure A.3-3. This label identifies the controlling authority responsible for the data description information for SFDU, the CCSDS version and class of SFDU, the unique data description identifier established by the controlling authority and the length in octets (8 bits) of the SFDU. The length attribute is the sum of the total lengths of the header aggregation CHDO and the telemetry CHDO.

	Bit															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Word	1	Controlling Authority														
	2															
	3	Version ID				Class ID										
	4	Spare														
	5															
	6	Data Description ID														
	7															
	8															
	9	Length Attribute														
	10															

**Figure A.3-3: Telemetry SFDU Label Physical Layout**

Table A.3-1 provides a description of each value field in the telemetry SFDU label. The origin column indicates the originating source for the data in each description field. These are further defined in Table A.3-2.

**Table A.3-1: Telemetry SFDU Label Field Descriptions**

Word	Bits	Description	Origin
1	1 — 16	Controlling Authority. Value = NJPL	
2	1 — 16		
3	1 — 8	SFDU Label Version: Value = 2	Fixed
	9 — 16	SFDU Classification. Value = Z	
4	1 — 16	Reserved. Value = 00 for DAS.	N/A
5	1 — 16	Data Description: Value = 0001	Fixed
6	1 — 16		
7	1 — 16	Length. In Octets	Computed
8	1 — 16		
9	1 — 16		
10	1 — 16		

**Table A.3-2: SFDU Header Fields Originating Source Definitions**

Origin	Definition
Fixed	The values of these header fields are constant. These header fields are maintained in the SFDU module and appended to each SFDU frame
Customer	The values of these header fields are input by the Customer are appended to SFDU frames on a per service basis.
Computed	The SFDU module in the PTP will compute these fields based on the SFDU length.
Time	The PTP computes the time fields based on the network socket buffer receipt time.
Requires VCP	These fields require the presence of a VCP.
N/A	These fields are not applicable to the SFDU header format used within the DAS PTP.

#### A.3.1.4.2 Header Aggregation CHDO Label

Words 11 and 12 of the telemetry SFDU contain the header aggregation CHDO label whose physical layout is illustrated in Figure A.3-4. This label identifies the type aggregation CHDO

and the total length of all subordinate headers in octets (72, based on 36 words (13-48 in Figure A.3-2) at 2 octets per word).

Bit																
Word	11	Type Attribute														
Word	12	Length Attribute														

**Figure A.3-4: Telemetry SFDU Header Aggregation CHDO Label Physical Layout**

Table A.3-3 provides a description of each value field in the header aggregation CHDO label. Table A.3-2 provides definitions of the origin column.

**Table A.3-3: Telemetry SFDU Header Aggregation CHDO Label Field Descriptions**

Word	Bits	Description	Origin
11	1 — 16	Type. Value = 1	Fixed
12	1 — 16	Length. In Octets. Value = 72	Computed

#### A.3.1.4.3 Primary Header CHDO Label

Words 13 through 16 of the telemetry SFDU contain the primary header CHDO. The physical layout is illustrated in Figure A.3-5. This header identifies the type of header (primary) and its length in octets as well the class of data (typically spacecraft), the configuration of the frame synchronization and RS decoding processes when the data in this SFDU were acquired, the mission ID, and a code indicating the source that formatted this SFDU.

Bit																
Word	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
13	Type Attribute															
14	Length Attribute															
15	Major Data Class						Minor Data Class									
16	Mission ID						Format Code									

**Figure A.3-5: Telemetry SFDU Primary Header CHDO Label Physical Layout**

Table A.3-4 provides a description of each value field in the primary header CHDO label. Table A.3-2 provides definitions of the origins column.

**Table A.3-4: Telemetry SFDU Primary Header CHDO Label Field Descriptions**

Word	Bits	Description	Origin
13	1 — 16	Type. Value = 2 for primary header	Fixed
14	1 — 16	Length. In Octets. Value = 4	
15	1 — 8	Major Data Class. Value = 1	
	9 — 16	Minor Data Class. Describes configuration of DAS frame synchronization and RS decoding at time of telemetry collection. Value = 0 - Frame Sync disabled; RS decoder disabled 1 - Frame Sync enabled; RS decoder disabled (basic DAS configuration) 2 - Frame Sync enabled; RS decoder enabled	Computed
16	1 — 8	Mission ID. Value range 0-255; unsigned binary integer	User <sup>1</sup>
	9 — 16	Format Code. Value = 0 for DAS.	N/A

Note 1: DAS will insert a zero (0) for Mission ID if a Mission ID is not provided by the Customer.

#### A.3.1.4.4 Secondary Header CHDO Label

Words 17 through 48 of the telemetry SFDU contain the secondary header CHDO label whose physical layout is illustrated in Figure A.3-6.

Word	Bit																																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16																				
17	Type Attribute																																			
18	Length Attribute																																			
19	Originator ID				Last Modifier ID																															
20	Spacecraft ID				Data Source ID																															
21	Error Flags																																			
22																																				
23	Earth Received Time (ERT)																																			
24																																				
25																																				
26	Record Sequence Number																																			
27																																				
28	Acquisition Bit Error Tolerance(BET)				Maintenance BET																															
29	Verify Count				Flywheel Count																															
30	Number of Received Telemetry Bits																																			
31	Frame Synch Mode Flags								Sync Status				Bit Slip																							
32	RS Symbol Error Counts (1 of 2)																																			
33	Sync Bit Errors				Frequency Band																															
34	Measured Bit Rate																																			
35																																				
36	RS Symbol Error Counts (2 of 2)																																			
37	System Noise Temperature																																			
38																																				

**Figure A.3-6: Telemetry SFDU Secondary Header CHDO Label Physical Layout**

	Bit																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16								
<b>39</b>	Symbol Signal to Noise Ratio (SNR)																							
<b>40</b>																								
<b>41</b>	Receiver Signal Level																							
<b>42</b>																								
<b>43</b>	Virtual Stream ID								Reserved															
<b>44</b>	Receiver ID																							
<b>45</b>	Telemetry Processor ID																							
<b>46</b>	Telemetry Lock Status																							
<b>47</b>	Telemetry Software ID																							
<b>48</b>	Reserved																							

**Figure A.3-6: Telemetry SFDU Secondary Header CHDO Label Physical Layout (cont'd)**

Table A.3-5 provides a description of each value field in the secondary header CHDO label. Table A.3-2 provides definitions of the origin column.

**Table A.3-5: Telemetry SFDU Secondary Header CHDO Label Field Descriptions**

Word	Bits	Description	Origin
17	1 — 16	Type. Value = 70	Fixed
18	1 — 16	Length. In Octets. Value = 60	
19	1 — 8	Originator. Value = 0	Fixed
	9 — 16	Last Modifier. Value = 0	
20	1 — 8	Spacecraft ID. Value range 0-255; binary unsigned integer	User <sup>1</sup>
	9 — 16	Data Source ID. Value = 0	Fixed
21	1 — 16	Time Error Flags. Bits = 1-7 – Reserved 8 – Status. Value = 0, if valid; 1 if invalid 9-16 – Reserved.	Computed
22	1 — 16	ERT. UTC. Days since 1 Jan. 1958 which equals 1.	
23	1 — 16	ERT. UTC. Milliseconds of the day	
24	1 — 16	ERT. UTC. Extended Resolution	
25	1 — 16	Record Sequence Number. Value = 1 to $2^{32}$ -1. Separate counters for each SFDU	
26	1 — 16	stream.	
27	1 — 16	Acquisition BET. Number of allowed bit errors in the synch marker during search and verify modes. Value range = 0-15	Computed
28	9 — 16	Maintenance BET. Number of allowed bit errors in the synch marker during lock and flywheel modes. Value range = 0-15	
29	1 — 8	Verify Count. Number of frames required during verify mode to transition to lock mode. Value range = 0-15	
	9 — 16	Flywheel Count. Number of frames required to transition to search mode. Value range = 0-15	
30	1 — 16	Number of Telemetry Bits. Number of Telemetry bits contained in the Telemetry Data CHDO. Binary unsigned integer. Unused bits at end of field to be ignored.	

Note 1: DAS will use the Spacecraft Identification Code (SIC) provided by the Customer in the service request SSC parameter as the Spacecraft ID.

**Table A.3-5: Telemetry SFDU Secondary Header CHDO Label Field Descriptions (cont'd)**

Word	Bits	Description	Origin
31	1 — 8	Frame Sync Flags. Value = 1 if set; or 0 if not set. If set, bit value means Bit 1 = User forced resynchronization Bit 2 = Reserved Bit 3 = Automatic Polarity Correction enabled Bit 4 = Frame Synchronizer is in flywheel more Bit 5 = Frame Synchronizer is in lock more Bit 6 = Frame Synchronizer is in verify more Bit 7 = Frame Synchronizer is in search more Bit 8 = Frame Synchronizer is in bypass more	Computed
	9	Data polarity flag. Value = 0 if true sync marker detected. 1 if complementary sync marker detected.	Computed
	10 — 13	Reserved. Value = 0 for DAS.	N/A
	14 — 16	Bit Slip Status. Value = 000 if frame is normal; else 011 if frame is 3 bits short; 111 if frame is 3 bits long; 010 if frame is 2 bits short; 110 if frame is 2 bits long; 001 if frame is 1 bit short; 101 if frame is 1 bit long.	Calculated
32	1 — 4	Reserved. Value = 0 for DAS.	N/A
	5 — 6	RS Decoder Status. Binary unsigned integer. Values = 0 - RS decoding Disabled 1 - RS codeblock received error-free 2 - RS codeblock received with errors and corrected. 3 - Not a RS codeblock	Calculated if VCP RS
	7 — 11	Number of corrected RS symbol errors in first byte of the transfer frame	
	12 — 16	Number of corrected RS symbol errors in second byte of the transfer frame	
33	1 — 8	Sync Bit Errors, if frame synchronizer invoked	Calculated
	9 — 16	Frequency band. Value = S	Fixed
34	1 — 16	Measured bit rate of attached telemetry. 32-bit floating point format to an accuracy of 0.1	
35	1 — 16	bits/second. Value = 0000 for DAS	N/A
35	1	Reserved	
	2 — 6	Number of corrected RS symbol errors in third byte of the transfer frame	
	7 — 11	Number of corrected RS symbol errors in fourth byte of the transfer frame	Calculated if VCP RS
	12 — 16	Number of corrected RS symbol errors in fifth byte of the transfer frame	
37	1 — 16	System Noise temperature in Kelvin. 32-bit floating point format. Value = 0000 for DAS	
38	1 — 16		
39	1 — 16		
40	1 — 16	Estimated Eb/No in dB. 32-bit floating point format. Value = 0000 for DAS	
41	1 — 16		
42	1 — 16	Receiver Signal Level in dBm. 32-bit floating point format. Value = 0000 for DAS	
43	1 — 8	Virtual Stream ID. Binary unsigned integer. Value range = 0-255. Value = 0 for DAS.	
	9 — 16	Reserved. Value = 0 for DAS.	
44	1 — 16	Receiver ID. Value = 00 for DAS	
45	1 — 16	Telemetry Processor ID. Value = 00 for DAS	
46	1 — 16	Telemetry Lock Status. Value = 00 for DAS	
47	1 — 16	Telemetry Software ID. Value = 00 for DAS	
48	1 — 16	Reserved. Value = 00 for DAS	

Note 1: DAS will use the Spacecraft Identification Code (SIC) provided by the Customer in the service request SSC parameter as the Spacecraft ID.

#### A.3.1.4.5 Telemetry CHDO Label

Words 49 through  $N$  of the telemetry SFDU contain telemetry CHDO label whose physical layout is illustrated in Figure A.3-7.

	Bit															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Word	49	Type Attribute														
	50	Length Attribute														
	51	Received Telemetry Bits														
	...															
	N															

**Figure A.3-7: Telemetry SFDU Telemetry CHDO Label Physical Layout**

Table A.3-6 provides a description of each value field in the telemetry CHDO label. Table A.3-2 provides definitions of the origins column.

**Table A.3-6: Telemetry SFDU Telemetry CHDO Label Field Descriptions**

Word	Bits	Description	Origin
49	1 — 16	Type. Value = 10	Fixed
50	1 — 16	Length. In Octets.	
51- N	1 — 16	Received telemetry bits. The number of bits contained in this field is given by word 14 of the secondary header CHDO. This field may contain a telemetry frame received from a spacecraft or a length of non-framed telemetry bits as indicated in the secondary header CHDO.	Computed

## A.3.2 AXAF-I Header

### A.3.2.1 General

The AXAF-I modification to the SFDU establishes a fixed length SFDU structure.

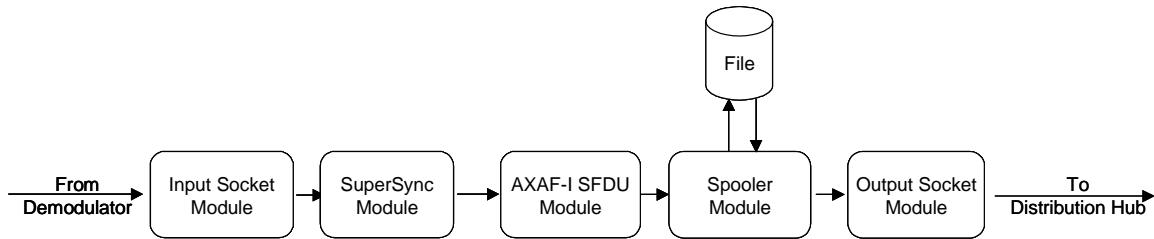
The baseline AXAF-I SFDU structure implemented by the PTP is based on the DSN AXAF-I as defined in DSN Telemetry Interface with MSFC for AXAF-I, DSN-830-013-TLM-3-26. However, for the DAS PTP implementation certain header fields are not implemented as indicated by the N/A originating source. DAS delivers AXAF-I SFDU's to Customers using the TCP/IP.

### A.3.2.2 AXAF-I Service Request Restrictions

When using this header format, the Customer must specify frame synchronization parameters and may optionally specify virtual channel processing in the service request. DAS will reject any request for this encapsulation header without a concurrent request for frame synchronization in the service request. DAS will also reject any request for this encapsulation header that includes a concurrent request for virtual channel processing without a concurrent request for frame synchronization in the service request.

### A.3.2.3 AXAF-I PTP Process

Figure A.3-8 illustrates a typical PTP desktop providing AXAF-I telemetry frame alignment and encapsulation using this version SFDU without any CCSDS processing.



**Figure A.3-8: Typical PTP Process for AXAF-I SFDU Encapsulation**

#### A.3.2.4 AXAF-I SFDU Header Layout

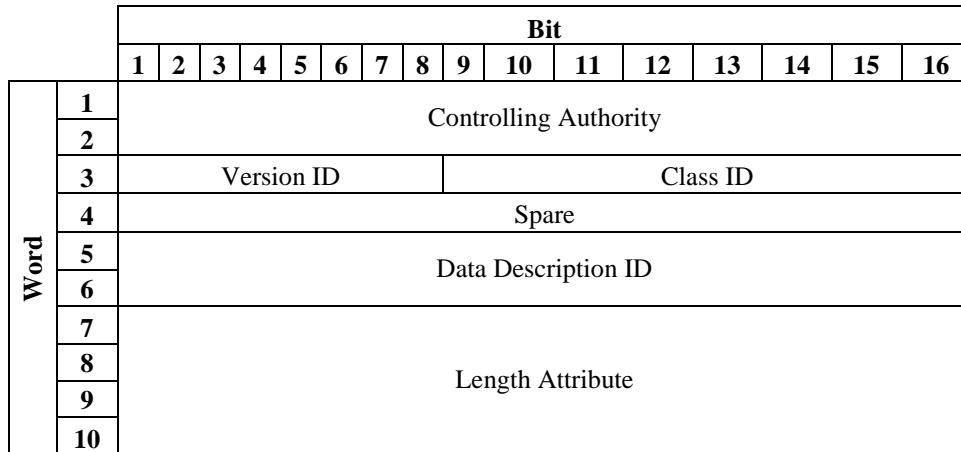
The AXAF-I SFDU format is illustrated in Figure A.3-9. Note that unlike the basic variable length SFDU, this is a fixed length structure.

Word	Bit															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Telemetry SFDU Label (10 Words)															
...																
10																
11	Header Aggregation CHDO Label (2 Words)															
12																
13	Primary Header CHDO Label (4 Words)															
...																
16																
17	Secondary Header CHDO Label (34 Words)															
...																
...																
50																
51	Telemetry Data CHDO Label (517 Words)															
...																
...																
567																

**Figure A.3-9: Telemetry AXAF-I SFDU Physical Layout**

##### A.3.2.4.1 AXAF-I Telemetry SFDU Label

The AXAF-I telemetry SFDU label format is illustrated in Figure A.3-10 and its field contents are described in Table A.3-7. This label and its contents are unchanged from the basic SFDU structure. Table A.3-8 provides definitions for the terms in the origin columns as they pertain to AXAF-I.



**Figure A.3-10: AXAF-I Telemetry SFDU Label Physical Layout**

**Table A.3-7: AXAF-I Telemetry SFDU Label Field Descriptions**

Word	Bits	Description	Origin
1	1 — 16	Controlling Authority. Value = NJPL	
2	1 — 16		Fixed
3	1 — 8	SFDU Label Version: Value = 2	
3	9 — 16	SFDU Classification. Value = Z	
4	1 — 16	Reserved. Value = 00 for DAS	N/A
5	1 — 16	Data Description: Value = 0001	Fixed
6	1 — 16		
7	1 — 16		
8	1 — 16		
9	1 — 16	Length, in octets of the Telemetry SFDU Words 11 through 567. Value = 1114	Computed
10	1 — 16		

**Table A.3-8: AXAF-I SFDU Header Fields Originating Source Definitions**

Origin	Definition
Fixed	The values of these header fields are constant. The header fields are maintained in the AXAF-I SFDU module and appended to each AXAF-I SFDU frame
Customer	The values of these header fields are input by the Customer and appended to AXAF-I SFDU frames on a per service basis.
Computed	The AXAF-I SFDU module in the PTP will compute these fields based on the AXAF-I SFDU length.
Time	The PTP computes the time fields based on the network socket buffer receipt time.
Requires VCP	These fields require the presence of a virtual channel processor.
VCP RS	These fields require the presence of a virtual channel processor to provide RS coding.
N/A	These fields are not applicable to the AXAF-I SFDU header format used within the DAS PTP.

#### A.3.2.4.2 AXAF-I Header Aggregation CHDO Label

The AXAF-I header aggregation CHDO label is shown in Figure A.3-11 and its field contents are described in Table A.3-9.

Bit																
Word	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
11	Type Attribute															
12	Length Attribute															

**Figure A.3-11: AXAF-I Header Aggregation CHDO Label Physical Layout**

**Table A.3-9: AXAF-I Header Aggregation CHDO Label Field Descriptions**

Word	Bits	Description	Origin
11	1 — 16	Type. Value = 1	Fixed
12	1 — 16	Length. In Octets. Value = 76	Computed

#### A.3.2.4.3 AXAF-I Primary Header CHDO Label

The AXAF-I primary header CHDO label is shown in Figure A.3-12 and its field contents are described in Table A.3-10. Table A.3-8 defines the terms in the origin columns of Table A.3-10 as they apply to AXAF-I.

Bit																
Word	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
13	Type Attribute															
14	Length Attribute															
15	Major Data Class								Minor Data Class							
16	Reserved															

**Figure A.3-12: AXAF-I Primary Header CHDO Label Physical Layout**

**Table A.3-10: AXAF-I Primary Header CHDO Label Field Descriptions**

Word	Bits	Description	Origin
13	1 — 16	Type. Value = 2 for primary header	Fixed
14	1 — 16	Length. In Octets of the Value fields. Value = 4	
15	1 — 8	Major Data Class. Value = 1 for spacecraft telemetry	User
15	9 — 16	Minor Data Class. Describes configuration of DAS frame synchronization and RS decoding at time of telemetry collection. Value = 0 – Frame Sync disabled; RS decoder disabled 1 - Frame Sync enabled; RS decoder disabled (basic DAS configuration) 2 - Frame Sync enabled; RS decoder enabled	Computed
16	1 — 16	Reserved. Value = 00 for DAS	N/A

#### A.3.2.4.4 AXAF-I Secondary Header CHDO Label

The AXAF-I secondary header CHDO label is illustrated in Figure A.3-13 and its field contents are described in Table A.3-11. Table A.3-8, earlier, defines the terms in the origin column of Table A.3-11.

Word	Bit															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
17	Type Attribute															
18	Length Attribute															
19	Originator ID				Last Modifier ID											
20	Spacecraft ID				Virtual Channel ID											
21	Error Flags															
22	Earth Received Time															
23	Record Sequence Number															
24	Acquisition BET															Maintenance BET
25	Verify Count															Flywheel Count
26	Number of Received Telemetry Bits															
27	Frame Synch Mode															Frame Sync Status
28	RS Decoder Status															Reserved
29	Sync Bit Errors															Frequency Band
30	Measured BIT Rate															
31	RS Symbol Error Count															
32	System Noise Temperature															
33	Symbol SNR															
34	Receiver Signal Level															
35	Reserved															
36	Master Antenna Number															Master Receiver Number
37	Deep Space Communications Complex (DSCC) Telemetry Subsystem (DTM) Group Number															DTM Channel Number
38																
39	Telemetry Lock Status															
40	DTM Software ID															
41	Reserved															
42	RS Symbol Error Count by Codeword															
43																
44																
45																
46																
47																
48																
49																
50																

**Figure A.3-13: AXAF-I Secondary Header CHDO Label Physical Layout**

**Table A.3-11: AXAF-I Secondary Header CHDO Label Field Descriptions**

Word	Bits	Description	Origin
17	1 — 16	Type. Value = 3 for secondary telemetry header.	Fixed
18	1 — 16	Length. In Octets. Value = 64	
19	1 — 8	Originator. Value = 0	Fixed
	9 — 16	Last Modifier. Value = 0	
20	1 — 8	Spacecraft ID. Value range 0-255; binary unsigned integer	User <sup>1</sup>
	9 — 16	Virtual Channel ID. Binary unsigned integer. Value = 0-63	Computed
21	1 — 7	Reserved. Value = 0 for DAS.	N/A
	8	ERT Status. Value = 0 if ERT valid; 1 if ERT invalid	Computed
	9 — 16	Reserved. Value = 0 for DAS.	N/A
22	1 — 16	ERT. Binary unsigned integers.	
23	1 — 16	Word 6. Days since 1 Jan. 1958 which equals 1.	
24	1 — 16	Words 7-8. Milliseconds of the day. Value range 0-86,400,000 (leap second)	Computed
25	1 — 16	Word 9. Microsecond of milliseconds. Value 000-999	
26	1 — 16	Record Sequence Number. Value = 1 to $2^{32}$ -1. Separate counters for each SFDU stream.	
27	1 — 16		
28	1 — 8	Acquisition BET. Number of allowed bit errors in the synch marker during search and verify modes. Value range = 0-15	
	9 — 16	Maintenance BET. Number of allowed bit errors in the synch marker during lock and flywheel modes. Value range = 0-15	
29	1 — 8	Verify Count. Number of frames required during verify mode to transition to lock mode. Value range = 0-15	Computed
	9 — 16	Flywheel Count. Number of frames required to transition to search mode. Value range = 0-15	
30	1 — 16	Number of Telemetry Bits. Number of Telemetry bits contained in the Telemetry Data CHDO. For AXAF-I, value = 8,232 (32-bit sync marker, 48-bit VCDU primary header and 8152-bit VCDU).	
31	1 — 8	Frame Sync Flags. Value = 1 if set; or 0 if not set. If set, bit means: Bit 1 = User forced resynchronization Bit 2 = Reserved Bit 3 = Automatic Polarity Correction enabled Bit 4 = Frame Synchronizer is in flywheel more Bit 5 = Frame Synchronizer is in lock more Bit 6 = Frame Synchronizer is in verify more Bit 7 = Frame Synchronizer is in search more Bit 8 = Frame Synchronizer is in bypass more	Computed
	9	Data polarity flag. Value = 0 if true sync marker detected; 1 if complementary sync marker detected.	Computed
	10 — 16	Reserved. Value = 0 for DAS.	N/A
32	1 — 8	RS Decoder Status. Binary unsigned integer. Values = 0 - RS decoding Disabled 1 - RS codeblock received error-free 2 - RS Codeblock received with errors and corrected. 3 - Not a RS codeblock	VCP RS

Note 1: DAS will use the SIC provided by the Customer in the service request SSC parameter as the Spacecraft ID.

**Table A.3-11: AXAF-I Secondary Header CHDO Label Field Descriptions (cont'd)**

Word	Bits	Description	Origin
	9 — 16	Reserved. Value = 0 for DAS.	N/A
33	1 — 8	Sync Bit Errors, if frame synchronizer invoked.	Computed
	9 — 16	Frequency band. For DAS, value = S	Fixed
34	1 — 16	Measured bit rate of attached telemetry. 32-bit floating point format to an accuracy of 0.1 bits/second. In ANSI/IEEE standard single precision format with a sign, 8-bit exponent, and 23 significant bits. Value = 000000 for DAS	N/A
35	1 — 16	RS Symbol errors. Value range 0-80.	
36	1 — 16	System Noise temperature in Kelvin. 32-bit floating point format to an accuracy of 0.1 Kelvin. Value = 0000 for DAS	VCP RS
37	1 — 16	Estimated Eb/No in dB. 32-bit floating point format. Value = 0000 for DAS	
38	1 — 16	Receiver Signal Level in dBm. 32-bit floating point format. Value = 0000 for DAS	N/A
39	1 — 16	Antenna ID. Value = 0 for DAS	
40	1 — 16	Receiver ID. Value = 0 for DAS	N/A
41	1 — 16	DTM Group No. Value = 0 for DAS	
42	1 — 16	DTM Channel No. Value = 0 for DAS	Fixed
43	1 — 16	Telemetry Lock Status. Value = 0 for DAS	
44	1 — 8	DTM Software ID. Value = 0 for DAS	N/A
	9 — 16	DTM Software Version ID. Value = 0 for DAS	
45	1 — 8	Number of RS Symbol errors corrected in first RS codeword block in this SFDU. Values= 0-16, 31. Binary unsigned integer. 31 = codeword uncorrectable.	VCP RS
	9 — 16	Number of RS Symbol errors corrected in second RS codeword block in this SFDU. Values= 0-16, 31. Binary unsigned integer. 31 = codeword uncorrectable.	
46	1 — 16	Number of RS Symbol errors corrected in third RS codeword block in this SFDU. Values= 0-16, 31. Binary unsigned integer. 31 = codeword uncorrectable.	N/A
47	1 — 8	Reserved. Value = 0 for DAS.	
48	1 — 16	Number of RS Symbol errors corrected in fourth RS codeword block in this SFDU. Values= 0-16, 31. Binary unsigned integer. 31 = codeword uncorrectable.	VCP RS
	6 — 10	Number of RS Symbol errors corrected in fifth RS codeword block in this SFDU. Values= 0-16, 31. Binary unsigned integer. 31 = codeword uncorrectable.	
49	11 — 15	Reserved. Value = 0 for DAS.	N/A
	16	Number of RS Symbol errors corrected in sixth RS codeword block in this SFDU. Values= 0-16, 31. Binary unsigned integer. 31 = codeword uncorrectable.	
50	1 — 5	Number of RS Symbol errors corrected in seventh RS codeword block in this SFDU. Values= 0-16, 31. Binary unsigned integer. 31 = codeword uncorrectable.	VCP RS
	6 — 10	Number of RS Symbol errors corrected in eighth RS codeword block in this SFDU. Values= 0-16, 31. Binary unsigned integer. 31 = codeword uncorrectable.	
	11 — 16	Reserved. Value = 0 for DAS.	N/A

#### A.3.2.4.5 AXAF-I Telemetry Data CHDO Label

The AXAF-I telemetry data CHDO label is illustrated in Figure A.3-14 and its field contents are described in Table A.3-12. Definitions for terms in the origin columns are provided in Table A.3-8.

	Bit															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Word	1	Type Attribute														
	2	Length Attribute														
	3	Received Telemetry Bits														
	...															
	517															

**Figure A.3-14: AXAF-I Telemetry Data CHDO Label Physical Layout**

**Table A.3-12: AXAF-I Telemetry CHDO Label Field Descriptions**

Word	Bits	Description	Origin
1	1 — 16	Type. Value = 10	Fixed
2	1 — 16	Length. In Octets. Value = 1030	
3 - 517	1 — 16	Received telemetry bits. For AXAF-I, this always contains 4-byte sync marker as received, 6-byte VCDU primary header, 1019-byte VCDU, followed by 1-byte pad	Computed

### A.3.3 ACE Header

#### A.3.3.1 General

ACE telemetry is delivered as virtual streams, consisting of a sequence of telemetry data blocks that encapsulate a modified SFDU.

The baseline ACE SFDU structure implemented by the PTP is based on the DSN ACE as defined in DSN Telemetry Interface with the ACE, DSN-830-013-TLM-3-27. However, for the DAS PTP implementation certain header fields are not implemented as indicated by the N/A originating source. DAS delivers ACE SFDU's to Customers using the TCP/IP.

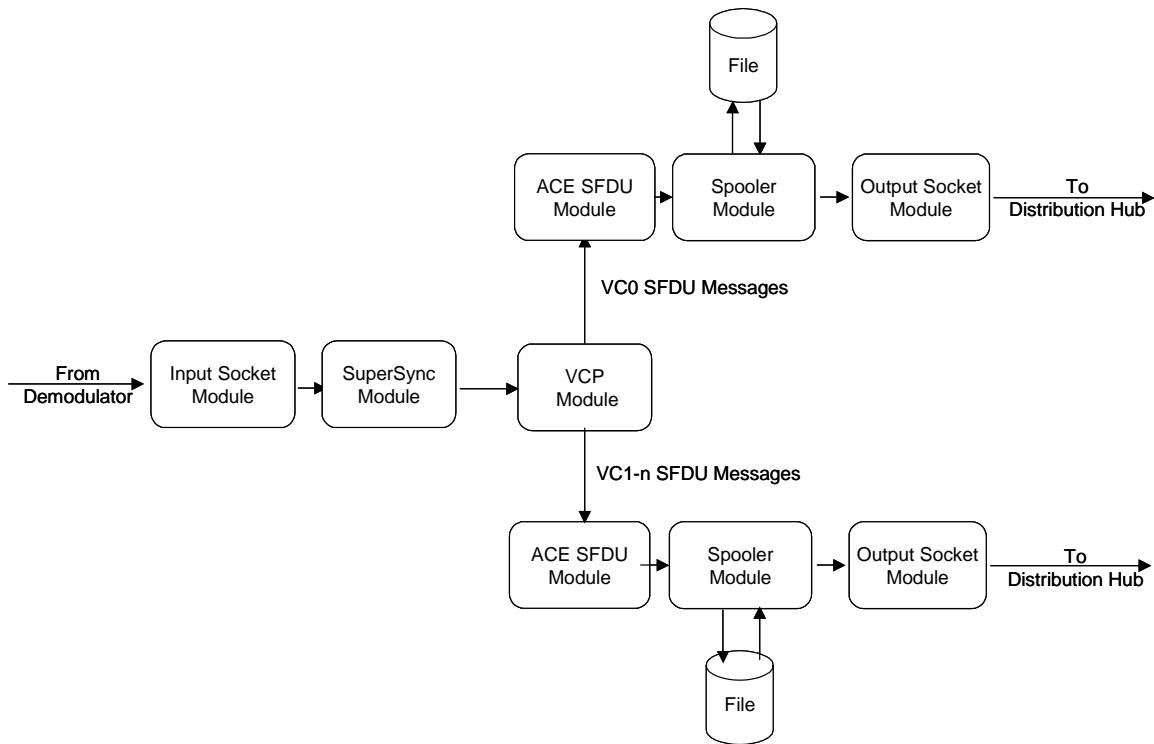
#### A.3.3.2 ACE Service Request Restrictions

When using this header format, the Customer must specify frame synchronization parameters and may optionally specify virtual channel processing in the service request. DAS will reject any request for this encapsulation header without a concurrent request for frame synchronization in the service request. DAS will also reject any request for this encapsulation header that includes a concurrent request for virtual channel processing without a concurrent request for frame synchronization in the service request.

The telemetry data blocks are typically RS encoded. Accordingly, DAS will pass on these blocks without RS decoding unless the Customer separately specifies RS decoding as part of the optional virtual channel processing parameters in the service request.

#### A.3.3.3 ACE PTP Process

Figure A.3-15 illustrates a typical PTP desktop providing ACE telemetry VCP to segregate the satellite housekeeping virtual channel from the science virtual channels and encapsulation using the ACE SFDU.



**Figure A.3-15: Typical PTP Process for ACE Virtual Channel Framing, Segregation and SFDU Encapsulation**

#### A.3.3.4 ACE SFDU Header Layout

The ACE SFDU is a fixed length structure similar to the AXAF-I SFDU; however, it is shorter than the AXAF-I structure. The ACE SFDU physical layout is shown in Figure A.3-16.

Word	Bit															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Telemetry SFDU Label (10 Words)															
10																
11	Header Aggregation CHDO Label (2 Words)															
12																
13	Primary Header CHDO Label (4 Words)															
16																
17	Secondary Header CHDO Label (32 Words)															
48																
49	Telemetry Data CHDO Label (500 Words)															
...																
548																

**Figure A.3-16: ACE SFDU Physical Layout**

#### A.3.3.4.1 ACE Telemetry SFDU Label

The ACE telemetry SFDU label layout is illustrated in Figure A.3-17 and its field contents are described in Table A.3-13. Note that it is identical to the AXAF-I telemetry SFDU label. Terms in the origin column are defined in Table A.3-14.

	Bit																										
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16											
Word	1	Controlling Authority																									
	2																										
	3	Version ID				Class ID																					
	4	Spare																									
	5	Data Description ID																									
	6																										
	7																										
	8																										
	9																										
	10	Length Attribute																									

**Figure A.3-17: ACE Telemetry SFDU Label Physical Layout**

**Table A.3-13: ACE Telemetry SFDU Label Field Descriptions**

Word	Bits	Description	Origin
1	1 — 16	Controlling Authority. Value = NJPL	Fixed
2	1 — 16		
3	1 — 8	SFDU Label Version: Value = 2	
	9 — 16	SFDU Classification. Value = Z	
4	1 — 16	Reserved. Value = 00 for DAS.	N/A
5	1 — 16	Data Description: Value = 0001	Fixed
6	1 — 16		
7	1 — 16	Length in Octets of the telemetry SFDU. Value = 1076 for ACE.	Computed
8	1 — 16		
9	1 — 16		
10	1 — 16		

**Table A.3-14: ACE Telemetry SFDU Header Fields Originating Source Definitions**

Origin	Definition
Fixed	The values of these header fields are constant. The header fields are maintained in the ACE SFDU module and appended to each SFDU frame
Customer	The values of these header fields are input by the Customer are appended to ACE SFDU frames on a per service basis.
Computed	The ACE SFDU module in the PTP will compute these fields based on the ACE SFDU length.
Time	The PTP computes the time fields based on the network socket buffer receipt time.
Requires VCP	These fields require the presence of a virtual channel processor.
VCP RS	These fields require the presence of a virtual channel processor to provide RS coding.
N/A	These fields are not applicable to the ACE SFDU header format used within the DAS PTP.

#### A.3.3.4.2 ACE SFDU Header Aggregation CHDO Label

The ACE SFDU header aggregation CHDO label structure and field content are identical to its AXAF-I counterpart. The ACE SFDU header aggregation CHDO label structure is illustrated at Figure A.3-18 and the field contents are described in Table A.3-15. Terms in the origin column are defined in Table A.3-14.

Word	Bit															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	11	Type Attribute														
Word	12	Length Attribute														

Figure A.3-18: ACE SFDU Header Aggregation CHDO Label Physical Layout

Table A.3-15: ACE SFDU Header Aggregation CHDO Label Field Descriptions

Word	Bits	Description	Origin
11	1 — 16	Type. Value = 1	Fixed
12	1 — 16	Length. In Octets. Value = 72	Computed

#### A.3.3.4.3 ACE Primary Header CHDO Label

The ACE primary header CHDO label structure and its field contents are identical to the AXAF-I. The primary header CHDO label structure is illustrated at Figure A.3-19 and the field contents are described in Table A.3-16. Terms in the origin column are defined in Table A.3-14.

Word	Bit																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
	13	Type Attribute															
	14	Length Attribute															
	15	Major Data Class								Minor Data Class							
	16	Reserved															

Figure A.3-19: ACE Primary Header CHDO Label Physical Layout

Table A.3-16: ACE Primary Header CHDO Label Field Descriptions

Word	Bits	Description	Origin
13	1 — 16	Type. Value = 2 for primary header	Fixed
14	1 — 16	Length. In Octets of the Value fields. Value = 4	Fixed
15	1 — 8	Major Data Class. Value = 1 for spacecraft telemetry	Fixed
15	9 — 16	Minor Data Class. Describes configuration of DAS frame synchronization and RS decoding at time of telemetry collection. Value = 0 - Frame Sync disabled; RS decoder disabled 1 - Frame Sync enabled; RS decoder disabled (basic DAS configuration) 2 - Frame Sync enabled; RS decoder enabled	Computed
16	1 — 16	Reserved. Value = 00 for DAS.	N/A

#### A.3.3.4.4 ACE Secondary Header CHDO Label

The ACE secondary header CHDO label is a 32-byte structure whereas the AXAF-I secondary header is a 34-byte structure. Both the layout and content, while similar to AXAF-I, are different. The ACE secondary header CHDO label structure is illustrated in Figure A.3-20 and the field contents are described in Table A.3-17. Terms in the origin column are defined earlier in Table A.3-14.

Word	Bit																											
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16												
17	Type Attribute																											
18	Length Attribute																											
19	Originator ID				Last Modifier ID																							
20	Spacecraft ID				Virtual Channel ID																							
21	Error Flags																											
22																												
23	Earth Received Time																											
24																												
25	Reserved																											
26	Record Sequence Number																											
27																												
28	Acquisition BET				Maintenance BET																							
29	Verify Count				Flywheel Count																							
30	Number of Received Telemetry Bits																											
31	Frame Synch Mode				Frame Sync Status																							
32	RS Symbol Error Count (1 of 2)																											
33	Sync Bit Errors				Frequency Band																							
34	Measured Bit Rate																											
35																												
36	RS Symbol Error Count (2 of 2)																											
37	System Noise Temperature																											
38																												
39	Symbol SNR																											
40																												
41	Receiver Signal Level																											
42																												
43	Reserved																											
44	Master Antenna Number				Master Receiver Number																							
45	DTM Group Number				DTM Channel Number																							
46	Telemetry Lock Status																											
47	DTM Software ID																											
48	Reserved																											

**Figure A.3-20: ACE Secondary Header CHDO Label Physical Layout**

**Table A.3-17: ACE Secondary Header CHDO Label Field Descriptions**

Word	Bits	Description	Origin
17	1 — 16	Type. Value = 70 for secondary telemetry header.	Fixed
18	1 — 16	Length. In Octets. Value = 60	
19	1 — 8	Originator. Value = 0	Fixed
	9 — 16	Last Modifier. Value = 0	
20	1 — 8	Spacecraft ID. Binary unsigned integer. Value range 0-255	User <sup>1</sup>
	9 — 16	Virtual Stream ID. Binary unsigned integer. Value = 1-64	Computed
	1 — 7	Reserved. Value = 0 for DAS.	N/A
21	8	ERT Status. Value = 0 if ERT valid; 1 if ERT invalid	Computed
	9 — 16	Reserved. Value = 0 for DAS.	N/A
22	1 — 16	ERT. Binary unsigned integers.	
23	1 — 16	Word 6. Days since 1/1/1958 which equals 1.	Computed
24	1 — 16	Words 7-8. Milliseconds of the day. Value range 0-86,400,000 (leap second)	
		Word 9. Microsecond of milliseconds. Value 000-999	
25	1 — 16	Reserved. Value = 00 for DAS.	N/A
26 - 27	1 — 32	Record Sequence Number. Value = 1 to $2^{32}$ -1. Separate counters for each SFDU stream.	
28	1 — 8	Acquisition BET. Number of allowed bit errors in the synch marker during search and verify modes. Value range = 0-15	
	9 — 16	Maintenance BET. Number of allowed bit errors in the synch marker during lock and flywheel modes. Value range = 0-15	
29	1 — 8	Verify Count. Number of frames required during verify mode to transition to lock mode. Value range = 0-15	
	9 — 16	Flywheel Count. Number of frames required to transition to search mode. Value range = 0-15	
30	1 — 16	Number of Telemetry Bits. Number of Telemetry bits contained in the Telemetry Data CHDO. For ACE, value = 7968 for VS 1 or VS2; = range 1-7968 for VS3.	Computed
31	1 — 8	Frame Sync Flags. Value = 1 if set; or 0 if not set. If set, bit means: Bit 1 = User forced resynchronization Bit 2 = Reserved Bit 3 = Automatic Polarity Correction enabled Bit 4 = Frame Synchronizer is in flywheel more Bit 5 = Frame Synchronizer is in lock more Bit 6 = Frame Synchronizer is in verify more Bit 7 = Frame Synchronizer is in search more Bit 8 = Frame Synchronizer is in bypass more	
	9	Data polarity flag. Value = 0 if true sync marker detected. 1 if complimentary sync marker detected.	
	10 — 16	Reserved. Value = 0 for DAS.	N/A
32	1 — 8	Number of RS Symbol errors corrected in first RS codeword block in this SFDU. Values = 0-16.	Computed if VCP RS
	9 — 16	Number of RS Symbol errors corrected in second RS codeword block in this SFDU. Values = 0-16.	

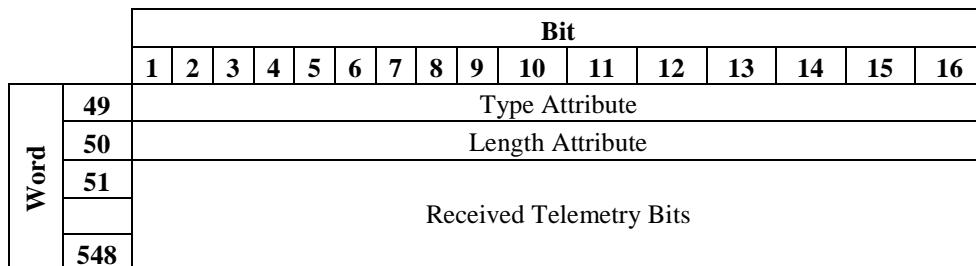
Note 1 DAS will use the SIC provided by the Customer in the service request SSC parameter as the Spacecraft ID.

**Table A.3-17: ACE Secondary Header CHDO Label Field Descriptions (con'td)**

Word	Bits	Description	Origin
33	1 — 8	Sync Bit Errors, if frame synchronizer invoked.	Computed
	9 — 16	Frequency band. For DAS, value = S	Fixed
34 - 35	1 — 32	Measured bit rate of attached telemetry. 32-bit floating point format to an accuracy of 0.1 bits/second. In ANSI/IEEE standard single precision format with a sign, 8-bit exponent, and 23 significant bits. Value = 0000 for DAS.	N/A
36	1 — 8	Number of RS Symbol errors corrected in third RS codeword block in this SFDU. Values= 0-16.	Computed if VCP RS
	9 — 16	Number of RS Symbol errors corrected in fourth RS codeword block in this SFDU. Values= 0-16.	
37 - 38	1 — 32	System Noise temperature in Kelvin. 32-bit floating point format to an accuracy of 0.1 Kelvin. Value = 0000 for DAS.	N/A
39 - 40	1 — 32	Estimated Eb/No in dB. 32-bit floating point format. Value = 0000 for DAS.	
41 - 42	1 — 32	Receiver Signal Level in dBm. 32-bit floating point format. Value = 0000 for DAS.	N/A
43	1 — 16	Reserved. Value = 00 for DAS	
44	1 — 8	Antenna ID. Value = 0 for DAS	N/A
	9 — 16	Receiver ID. Value = 0 for DAS	
45	1 — 8	DTM Group No. Value = 0 for DAS	N/A
	9 — 16	DTM Channel No. Value = 0 for DAS	
46	1 — 16	Telemetry Lock Status. Value = 0 for DAS	N/A
47	1 — 8	DTM Software ID. Value = 0 for DAS	
	9 — 16	DTM Software Version ID. Value = 0 for DAS	
48	1 — 16	Reserved. Value = 00 for DAS	N/A

#### A.3.3.4.5 ACE Telemetry Data CHDO Label

The ACE telemetry data CHDO label contains the Customer telemetry. This structure is 17 bytes shorter than AXAF-I given the different telemetry frame lengths. The ACE telemetry data CHDO label structure is illustrated in Figure A.3-21 and the field contents are described at in Table A.3-18.



**Figure A.3-21: ACE Telemetry Data CHDO Label Physical Layout**

**Table A.3-18: ACE Telemetry Data CHDO Label Field Descriptions**

Word	Bits	Description	Origin
49	1 — 16	Type. Value = 10	Fixed
50	1 — 16	Length. In Octets. Value = 996	
51 -548	1 — 16	Received telemetry bits.	Computed

### A.3.4 Low Earth Orbit – Terminal (LEO-T) Transport Header

#### A.3.4.1 General

The LEO-T header is a specialized header suitable for general ground transport of spacecraft telemetry data. It is a variable length frame based on 16-bit (2-octet) words.

The baseline LEO-T header structure implemented by the PTP is based on the header definition as defined in Epoch2000 LEO-T Operations and Maintenance Manual. However, for the DAS PTP implementation certain header fields are not implemented as indicated by the N/A originating source.

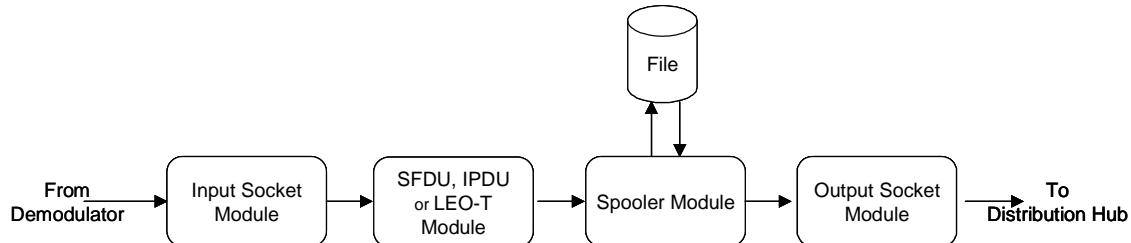
#### A.3.4.2 LEO-T Service Request Restrictions

When using this header format, the Customer may specify frame synchronization parameters and virtual channel processing parameters in the service request. DAS will reject any request for this encapsulation header that includes a concurrent request for virtual channel processing without a concurrent request for frame synchronization in the service request.

When using this header, the Customer may also specify a data class identification in the service request, which DAS will insert as a binary unsigned number in Word 2 of the header.

#### A.3.4.3 LEO-T PTP Process

Figure A.3-22 illustrates a typical PTP desktop providing telemetry encapsulation using the LEO-T header.



**Figure A.3-22: Typical PTP Process for LEO-T Header Encapsulation**

#### A.3.4.4 LEO-T Transport Header Layout

The format for the LEO-T header is shown in Figure A.3-23 and the field descriptions are provided in Table A.3-19. The terms shown in the origin column are defined in Table A.3-20.

	Bit																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16				
Word	1	Ver	Frame Length																	
	2	*	*	*	*	*	*	*	*	*	*	*	Data Class							
	3	ERT																		
	4	ERT																		
	5	ERT																		
	6	Telemetry Data Bits																		
	N	* See field description table																		

**Figure A.3-23: LEO-T Header Physical Layout**

**Table A.3-19: LEO-T Header Field Descriptions**

Word	Bits	Description	Origin
1	1 — 2	Version Number for Value = 01	Fixed
	3— 16	Length of frame <i>in bytes</i> , including the delivery header	Computed
2	1	RS encoding. Value = 0 if disabled, 1 if enabled	Computed
	2	RS decoding error. Value = 0 if frame was corrected, 1 if frame could not be corrected	Requires VCP RS
	3	Frame CRC checking. Value = 0 if disabled, 1 if enabled	
	4	Frame CRC error. Value = 0 if pass, 1 fail	
	5	Master Channel Sequence checking. Value = 0 if disabled, 1 if enabled	Requires VCP
	6	Master Channel Sequence checking. Value = 0 if number increased monotonically, 1 if number is out of sequence	
	7 — 8	Data inversion flags. Value = 00 if data true 01 if data inverted 11 if data inverted and corrected	
	9 —10	Frame Sync Mode Flags. Value = 00 if search frame 01 if check frame 10 if lock frame 11 if flywheel frame	
	11	Data forward/reverse flag. Value = 0 for DAS.	N/A

**Table A.3-19: LEO-T Header Field Descriptions (con'td)**

Word	Bits	Description	Origin
2	11	Data forward/reverse flag. Value = 0 for DAS.	N/A
	12 — 16	Data Class. Value = 1 if CCSDS Frame 2 if CCSDS Packet 3 if TDM Frame 4 if Stripped TDM Frame	User <sup>1</sup>
3 — 5		Network Socket Receive Time as defined below. This is the UTC time when the frame is received by the telemetry processor.	Time
3	1	PB-5 Flag. Value set to "0"	Fixed
	2 — 15	Truncated Julian Day (14 bits). Truncate the most significant bits retaining only the four least significant decimal digits, ranging from 0000 to 9999. Current Julian Day epoch begins 10 Oct. 1995 and continues for 27 years.	Time
	16	Seconds of the Day (17 bits). Most significant bit, see Word 4	
4	1 — 16	Seconds of the Day (17 bits). 16 least significant bits. Value range 0 to 86,399.	
5	1 — 10	Millisecond of the second. Value range 0 to 999	
	11 — 16	Spares. Set to zeros.	Fixed
6 — N		Telemetry bits	Computed

Note 1: If no value is provided in the service request SSC parameter, DAS will insert a value of zeros.

**Table A.3-20: LEO-T Header Fields Originating Source Definitions**

Origin	Definition
Fixed	The values of these header fields are constant. The header fields are maintained in the LEO-T module and appended to each IPDU frame
Customer	The values of these header fields are input by the Customer and appended to LEO-T frames on a per service basis
Computed	The LEO-T module in the PTP will compute these fields based on the LEO-T length.
Time	The PTP computes the time fields based on the network socket buffer receipt time.
Requires VCP	These fields require the presence of a virtual channel processor.
N/A	These fields are not applicable to the LEO-T header format used within the DAS PTP.

## A.3.5 IPDU Header

### A.3.5.1 General

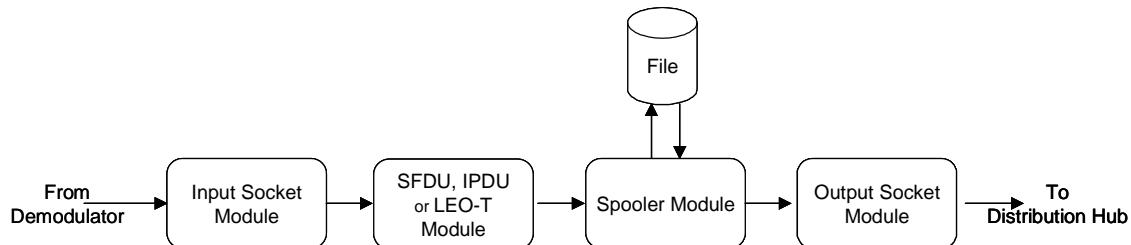
The IPDU transport header appends data quality information based on ground station processing. The baseline IPDU header structure implemented by the PTP is based on the header definition as defined in ICD between LANDSAT-7 and LANDSAT-7 Ground Network, 430-14-01-001-0, Appendix C. However, for the DAS PTP implementation certain header fields are not implemented as indicated by the N/A originating source.

### A.3.5.2 IPDU Service Request Restrictions

When using this header format, the Customer may specify frame synchronization and virtual channel processing parameters in the service request. DAS will reject any request for this encapsulation header that includes a concurrent request for virtual channel processing without a concurrent request for frame synchronization in the service request.

### A.3.5.3 IPDU PTP Process

Figure A.3-24 illustrates a typical PTP desktop providing telemetry encapsulation using the IPDU header.



**Figure A.3-24: Typical PTP Process for IPDU Header Encapsulation**

### A.3.5.4 IPDU Header Layout

The IPDU 32-byte header precedes the telemetry TCP/IP packets. The IPDU header layout is shown in Figure A.3-25 and field contents are defined in Table A.3-20. The terms shown in the origin column of Table A.3-21 are defined in Table A.3-22.

		Bit							
		1	2	3	4	5	6	7	8
Word	1	IPDU Synchronization							
	2								
	3								
	4								
	5	IPDU Length							
	6								
	7								
	8								
	9	IPDU Source							
	10	IPDU Destination							
	11	Message Type							
	12	Spare							
	13	Header Ver		Data Type					
	14								
	15								
	16	Message Time (GMT)							
	17								
	18								
	19								
	20								
	21	Ground Station Port ID							
	22	*	*	*	*	*	*	*	*
	23	*	Spacecraft ID ...						
* See field description table									

**Figure A.3-25: IPDU Header Physical Layout**

	Bit							
	1	2	3	4	5	6	7	8
24	S/C ID	Virtual Channel ID						
25	Location of first Octet of DAS-generated fill data							
26								
27								
28	Spare							
29								
30								
31	*	VCDU Hdr Err Result						
32	VCDU Error Result							
* See field description table								

**Figure A.3-25: IPDU Header Physical Layout (cont'd)**

**Table A.3-21: IPDU Header Field Descriptions**

Word	Bits	Description	Origin
1	1 — 8		
2	1 — 8	IPDU Sync, unsigned integer, Value = 74C2472C hex	Fixed
3	1 — 8		
4	1 — 8		
5	1 — 8		
6	1 — 8	IPDU Length in bytes, unsigned integer	Computed
7	1 — 8		
8	1 — 8		
9	1 — 8	IPDU Source, unsigned integer. Value = 0 for DAS.	N/A
10	1 — 8	IPDU destination, unsigned integer. Value = 0 for DAS.	
11	1 — 8	Message Type. Value = 01 = narrowband real-telemetry 02 = narrowband spacecraft recorder playback 03 = command data message (not applicable to DAS) 04 = command echo message (not applicable to DAS) 05 = one-way tracking data (not applicable to DAS) 06 = two-way tracking data (not applicable to DAS)	Computed
12	1 — 8	Spare. Value = 0 for DAS.	N/A
13	1 — 4	Header Version Number, unsigned integer	Fixed
	5 — 8	Data Type, unsigned integer	
14	1 — 8	Network Socket Receive Time (GMT), using NASA PB-5 Time Code Format, where	
15	1 — 8	Bits	
16	1 — 8	1 = Flag Bit = 1	
17	1 — 8	2-14 = Truncated Julian Day, four least significant digits; 0 = 10/10/1995, 00 hrs	
18	1 — 8	15-32 = Seconds of Day, range = 00000-86399	
19	1 — 8	33-42 = Milliseconds of Second, range = 000-999	
20	1 — 8	43-52 = Microsecond of Millisecond, range = 000-999	
	53-56	Spare. Value = 0	

**Table A.3-21: IPDU Header Field Descriptions (cont'd)**

Word	Bits	Description	Origin
21	1 — 8	Ground Station Physical Port ID. Value = 0 for DAS.	N/A
	1	Source VCDU Sequence discontinuity flag. 0 = no discontinuity; 1 = discontinuity	VCP
	2	Playback flag. 0 = real-time telemetry; 1 = playback telemetry. Value = 0 for DAS.	
	3	Recovery flag. 0 = live from spacecraft; 1 = playback from ground station. Value = 0 for DAS.	N/A
22	4	Test Data Flag. 0 = operational data; 1 = test data. Value = 0 for DAS.	
	5	CRC Failure Flag. 0 = valid CRC; 1 = failed CRC	
	6	Path SDU sequence discontinuity flag. 0 = no discontinuity; 1 = discontinuity	VCP
	7	Packet Length error flag. 0 = no error; 1 = error. Value = 0 for DAS.	
	8	Packet Fill Flag. 0 = no fill; 1 = fill. Value = 0 for DAS.	N/A
23	1 — 2	Spare. Value = 0 for DAS.	
	3 — 8	Spacecraft ID	
24	1 — 2	Spacecraft ID (cont'd)	
	3 — 8	Virtual Channel ID. Value = 0 for DAS.	
25	1 — 8	Location of first octet of ground-generated fill data for a path SDU, unsigned integer.	
26	1 — 8	Value = 00 for DAS.	
27	1 — 8		
28	1 — 8		
29	1 — 8		
30	1 — 8		
	1	RS Error Flag. 0 = no errors or errors corrected; 1 = uncorrectable errors	VCP RS
31	2 — 6	Source VCDU Header error decode results, 5 bits, unsigned integer. Value = 0 for DAS.	
	7 — 8	Source VCDU error decode results, first 2 of 10 bits, unsigned integer. Value = 0 for DAS.	
32	1 — 8	Source VCDU error decode results, remaining 8 of 10 bits, unsigned integer. Value = 0 for DAS.	N/A

Note 1: DAS will use the SIC provided by the Customer in the service request SSC parameter as the Spacecraft ID.

**Table A.3-22: IPDU Header Fields Originating Source Definitions**

Origin	Definition
Fixed	The values of these header fields are constant. The header fields are maintained in the IPDU module and appended to each IPDU frame
Customer	The values of these header fields are input by the Customer and appended to IPDU frames on a per service basis.
Computed	The IPDU module in the PTP will compute these fields based on the IPDU length.
Time	The PTP computes the time fields based on the network socket buffer receipt time.
Requires VCP	These fields require the presence of a virtual channel processor.
N/A	These fields are not applicable to the IPDU header format used within the DAS PTP.

# Abbreviations and Acronyms

---

ACE	Advanced Composition Explorer
AXAF-I	Advanced X-ray Astrophysics Facility-Imagery
BET	Bit Error Tolerance
CCB	Configuration Control Board
CCR	Change Control Record
CCSDS	Consultative Committee for Space Data Systems
CDB	Common Data Broadcast
CHDO	Compressed Header Data Object
CRC	Cyclic Redundancy Check
CSMA/CD	Carrier Sense Multiple Access with Collision Detection
CTFS	Common Time and Frequency System
CVCDU	Coded Virtual Channel Data Unit
DAS	Demand Access System
DASCON	DAS Controller
DCN	Documentation Control Notices
DCON	DMG Controller
DMG	Demodulator Group
DNS	Domain Name System
DSN	Deep Space Network
DTM	Deep Space Communications Complex (DSCC) Telemetry Subsystem
EBNet	EOS Backbone Network
ECON	EMC Controller
EMC	Element Multiplexer Correlator
ERT	Earth Receive Time
EOS	Earth Observing System
GDIS	Guam Data Interface System
GRGT	Guam Remote Ground Terminal
ICD	Interface Control Document
ID	Identification
IETF	Internet Engineering Task Force
IONet	IP Operational Network
IP	Internet Protocol
IPDU	Internet Protocol Data Unit
LAN	Local Area Network
LEO-T	Low Earth Orbit - Terminal
LGN	LANDSAT-7 Ground Network

LI	Local Interface
MAR	Multiple Access Return
MOC	Mission Operations Center
MSFC	Marshall Space Flight Center
N/A	Not Applicable
NASA	National Aeronautics and Space Administration
NJPL	NASA's Jet Propulsion Lab
NCC	Network Control Center
NISN	NASA Integrated Services Network
NPG	NASA Procedures and Guidelines
PTP	Programmable Telemetry Processors
RFC	Designation for an IETF Standard
RJ-45	Registered Jack Number-45 (8-wire connector)
RS	Reed-Solomon
RS-422	Differential Serial Interface Standard
RX	Receiver, Reception
SFDU	Standard Formatted Data Unit
SGLT	Space Ground Link Terminal
SIC	Spacecraft Identification Code
SNR	Signal to Noise Ratio
SNUG	Space Network User's Guide
SSC	System/Subsystem Controller
	Service Specification Code
SWSI	Space Network Web Services Interface
TCP	Transmission Control Protocol
TCP/IP	Transmission Control Protocol/Internet Protocol
TDM	Time Division Multiplex
TDRS	Tracking and Data Relay Satellite
TFDH	Telemetry Frame Delivery Header
TLM	Telemetry
TX	Transmitter, Transmission
UTC	Universal Time Coordinated
VCDU	Virtual Channel Data Units
VCP	Virtual Channel Processor
WAN	Wide Area Network
WDISC	WSC Data Interface Service Capability
WSC	White Sands Complex
WSGT	White Sands Ground Terminal